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EVALUATION OF A RELIABILITY ANALYSIS APPROACH TO FATIGUE LIFE VARIABILITY OF AIRCRAFT STRUCTURES USING C-130 IN-SERVICE OPERATIONAL DATA

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TECHNICAL REPORT AFML-TR-70-272

FEBRUARY 1971

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241

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FOREWORD

This report was prepared by Lockheed-Georgia Company, a Division of Lockheed Aircraft Corporation. The work was conducted under Contract No. F33615-70-C-1252, which was initiated and jointly supported by the Air Force Flight Dynamics Laboratory under Project No. 1467, "Structural Analysis Methods", Task No. 146704, "Structural Fatigue Analysis", and the Air Force Materials Laboratory under Project No. 7351, "Metallic Materials", Task No. 735106, "Behavior of Metals", with Mr. R. C. Donat, AFML/LLD, acting as project engineer.

The study on which this report is based was conducted by the Structural Materials Development Department of the Advanced Structures Division under the technical supervision of Mr. W. A. Pitman. Mr. C. S. Sarphie was the Program Manager for Lockheed.

This is a final report and represents the technical work conducted from February to October 1970. The manuscript of this report was released by the authors December 1970. The contractor's designation of this report is ER 10700.

This study was conducted by Mr. Claude S. Sarphie and Mr. Robert S. Watson of the Fatigue and Fracture Mechanics Unit. Acknowledgement is due Mr. B. Tilt for his contributions to the development of the analytical methods, to Mrs. Ginger R. Lupy for developing the computer program, to Mr. John M. Firebaugh and Mr. Earl A. Blount for the development of the usage groups, and to Mr. Wayne L. Davidson for the computation of the fatigue endurance. The typing of this report was done by Mrs. Carolyn L. Chadwick.

This technical report has been reviewed and is approved.

W. J. Trapp

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ABSTRACT

An analytical program to evaluate a probabilistic analysis approach to the prediction of aircraft structural fatigue endurance using data obtained from the C-130 Structural Integrity Program has been completed. This report is the final report of this program.

The proposed method is applied to three fatigue sensitive areas of the C-130 center wing using test results from C-130 B and E wing full scale fatigue tests. The results of this analysis are then correlated with service experience data from the Air Force's fleet of C-130 B and E transport aircraft. In addition, this data is also used to consider the applicability of the basic distributions and parameters selected for the proposed method.

The first and second phases of the program involve the preparation of this data and the correlation of the results of the analysis with the data used as a single population. The third and fourth phases of the program involve the selection of four C-130 service usage groups, the adjustment of the fatigue test results to the usage group loads and the correlations of the results of each analysis with the data from each usage group. The fifth phase involves a review of the results of the correlations made in this study.

This study indicates that either the log-normal or Weibull distributions with the proposed shape parameters fit C-130 in-service crack initiation as well as present knowledge could predict. Predictions made with the proposed method are significantly more conservative than their nominal reliability values would indicate.

It is recommended that a modification of the present method be considered which uses crack occurrence results from the fleet along with the fatigue test results for estimating the fatigue endurance.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

ILLUSTRATIONS (Continued)

ILLUSTRATIONS (Continued)

ILLUSTRATIONS (Continued)

ILLUSTRATIONS (Continued)

LIST OF TABLES

TABLES (Continued)

TABLES (Continued)

TABLES (Continued)

TABLES (Continued)

NOMENCLATURE

F	$=\sqrt{2\chi^2} - \sqrt{2n^1 - 1}$, expression for the normal deviate with unit variance. This value is used when $n^1 > 30$ as input into a table for "Normal Curve for Error" to determine P.
P	Probability that theoretical distribution can give a larger value of χ^2. This value is taken from a table for χ^2 when $\eta^1 < 30$ and from a table for "Normal Curve for Error" when $\eta^1 > 30$.
T_i	i^{th} test result in equivalent flight hours.
n	Test sample size.
n_f	Number of test failures.
η^1	Degrees of Freedom
α	Shape parameter for Weibull distribution.
β	Scale parameter for Weibull and log-normal distributions.
σ	Variance for log-normal distribution.
χ_1^2	Chi-squared value for entire fleet.
χ_2^2	Chi-squared value includes only those aircraft that have early crack initiation.
K_t	Quality Level
$\bar{R}$	Reliability of the structural component.
W.S.	Wing Station

The following terms are defined because their meaning as used in this report may not be generally understood.

Data Block - A unique combination of operational parameter bands. The data blocks are selected to envelope the full range of aircraft operational usage.

Fatigue Crack - A crack in a structural member which is detectable by normal inspection procedures and is caused by a series of loads which produce average stresses less than the material ultimate stress of the member.

Fatigue Damage - A proportion of the fatigue endurance of a structural component which has been expended.

Fatigue Endurance - The computed time to fatigue crack initiation in a structure based on a defined operational usage, expressed in terms of flight hours, landings, special operations and/or fuselage pressurizations.

Operational Usage - The in-service usage of an aircraft or fleet of aircraft in terms of the mission profiles and utilization.

Operational Parameters - Parameters which significantly affect the fatigue damage incurred during operation of an aircraft.

Quality Level - That value of stress concentration factor which would define the S-N curve that satisfies the condition of the Palmgren-Miner Theory of Cumulative Damages in terms of the fatigue crack initiation and the applied test spectra.

S-N Curves - Data which define the number of cycles (N) of a given stress intensity (S) required to produce initiation of a crack in the structure. These data are obtained by testing notched specimens of a given material.

They are normally presented as curves of stress versus cycles to crack initiation at a constant quality level for a given material.

Test Specimen Endurance - The number of simulated service hours or flights which a specimen sustained in a fatigue test at the time a crack was detected.

SECTION I

INTRODUCTION

This is the final report of a program the object of which is to evaluate the probabilistic method proposed in AFML-TR-69-65 (Reference 1) for predicting the fatigue endurance of an aircraft structure. The data used in this evaluation are the results from two full scale fatigue tests on C-130 B and C-130 E wings and the service experience data from 439 aircraft in the Air Force's C-130 B and C-130 E fleet.

The approach used in the method under consideration has resulted from a proposal by Dr. A. M. Freudenthal of George Washington University that the expected time to the initiation of the first crack is a more relevent concept for the prediction of the fatigue endurance of major aircraft structure than the conventional concept of the expected endurance coupled with a scatter factor. The Boeing Company has been primarily responsible for the development of the constants required to complete the implementation of this concept into a practical engineering method. This work was sponsored jointly by the Air Force Flight Dynamics Laboratory and the Air Force Materials Laboratory.

The results of this study are to serve as a basis for determining the adequacy of the referenced method for predicting the time to crack initiation of a structural component of an aircraft within a fleet using the results from full scale fatigue tests of the structure.

SECTION II

PROGRAM DESCRIPTION

The program is divided into five working phases. A brief description of each of these phases follows.

Phase I - Data Collection - The object of this phase is to gather and prepare the available C-130B and C-130E fatigue test results and service experience data for use in the correlation of Phases II, III, and IV.

The fatigue test results used are the equivalent flight time to initiation of fatigue cracks at three critical areas on the center wing. These results are obtained from the full scale fatigue tests of the C-130B and C-130E wings. The service experience data is the time to the initial cracks at the three critical areas on the center wing of each C-130B and C-130E aircraft. This service data has been obtained from the C-130 Fatigue Life Monitoring Program currently in progress at the Lockheed-Georgia Company.

The three critical areas referred to above are defined as follows: Critical Area 1 refers to skin panel cracks at W.S. 38, the termination of the reinforcing structure surrounding the cutout located on the upper surface of the C-130 center wing at the center line of the aircraft. Critical Area 2 refers to skin panel cracks that occur at W.S. 105, the inboard termination of the reinforcing structure surrounding the cricular cutout located on the upper surface at W.S. 120.5. Critical Area 3 refers to skin cracks that occur at fastener holes in the corners of a rectangular cutout located on the lower surface at W.S. 120.5.

Phase II - <u>Initial Correlation</u> - The object of this phase is to correlate the results of the method proposed in Reference 1 with the service experience data from the fleet of C-130B's and C-130E's used as a single population.

In this phase the proposed method (using both the Weibull and log-normal distributions) is applied to the fatigue test data collected in Phase I for each critical area. From this application of the theoretical method a distribution of the probabilities of times to crack initiation for each critical area is developed; these distributions are herein called the "theoretical distributions". In addition the empirical distributions of the actual probabilities of times to the initiation of the first cracks at each critical area on the C-130B and C-130E aircraft in service are developed. These distributions, which are developed from the C-130 service experience data collected and processed in Phase I, are herein called the "apparent empirical distributions". Then each theoretical distribution is correlated with the corresponding apparent empirical distribution using the Chi-Square test to give a quantitative measure of the goodness of fit.

For another test of the accuracy of the proposed method, several Weibull and log-normal distributions are developed which best fit the apparent empirical distribution of the C-130 service experience data for each area. These best fit distributions are then correlated with the corresponding apparent empirical distribution again using the Chi-Square test to give a quantitative measure of the fit.

As a third test, the proposed method's prediction of the safe life for each of the structural components is calculated and then compared with the corresponding lowest times to crack initiation from the C-130 service experience data for each critical area. These safe life predictions are calculated by applying the proposed method of Reference 1 to the fatigue test results processed in Phase I.

Phase III - Correlation by Usage Groups - The object of this phase is to correlate the results of the proposed prediction method calculated for each of several C-130 service usage groups (using the C-130 fatigue test results) with the service experience data from the aircraft in that usage group.

This phase has been included in the program because the wide range of missions for which the C-130 has been used make it virtually impossible for any chosen test load spectrum to represent any single aircraft or group of aircraft. However, one basic condition of the proposed method is that the test load spectrum used in the safe life prediction is representative of the operational loading. It is reasonable to expect, therefore, that the results of the Phase II correlation, in which the data is used as a single population, will not be ideal. Consequently, in this and in the next program phase, the information available describing the wide variation of C-130 usage is used to evaluate the method further through additional correlations.

The C-130B and C-130E aircraft forming the population samples in this study are separated into usage groups corresponding to their base assignments. This distinction is used because C-130 aircraft assigned to certain bases generally fly specific types of missions.

New apparent empirical distributions are developed for each critical area from the service experience data for the aircraft in each of the service usage groups chosen above. The new theoretical distributions calculated for each critical area and usage group are correlated with each of these apparent empirical distributions by using the Chi-Square test.

Again, Weibull and log-normal distributions are generated which best fit the service experience data from the C-130 aircraft in each of the service usage groups. Then each of these "best fit" distributions is correlated with the corresponding apparent empirical distribution as generated above. A quantitative measure of this correlation is determined using the Chi-Square test.

Phase IV - Correlation With Usage Group Adjustment - The object of this phase is to correlate the results of a proposed analysis, made using the C-130 fatigue test results which have been normalized to each usage group's load profiles, with the service experience data from the aircraft in the corresponding C-130 usage group.

The load profiles corresponding to each of the service usage groups determined in Phase III are developed. The equivalent fatigue test results are calculated by normalizing the C-130B and C-130E wings' full scale fatigue test results for each critical area to each usage group's load profiles.

The proposed method (using both the Weibull and the log-normal distributions) is applied to the equivalent fatigue test results, as calculated above for each usage group, to develop the several new theoretical distributions required. Each of these new theoretical distributions is then correlated with the appropriate apparent empirical distribution generated in Phase III for the same usage group. The Chi-Square test is applied to this correlation.

A safe life prediction is calculated for each critical area by the proposed prediction method (using both the Weibull and log-normal distributions) from the equivalent fatigue test results for each usage group. Each of these safe life predictions is then compared with the time to crack initiation data for the aircraft in the corresponding usage group.

Phase V - Review and Recommendations - The object of this phase is to evaluate the prediction method using the results of the previous correlations for the purpose of determining the validity of the method in its present form. A second objective is to develop recommendations for modifications to the method as necessary to improve it or for any modified approaches which may be more appropriate.

SECTION III

C-130 FATIGUE TESTS AND SERVICE DATA

Since test results and service data from the C-130B and E aircraft are used in this program as a basis for the evaluation of the method proposed in Reference 1, a description of the C-130 is presented in this section.

The C-130 airplane is a turboprop transport designed and built by the Lockheed-Georgia Company for the U. S. Air Force. A total of more than 1,100 C-130's have been built and the aircraft is currently in production.

There are several basic models of the C-130. These are the C-130A, C-130B, C-130E and C-130H models. Several variations of each of these basic models have been built and are used in a variety of different missions.

The C-130A, the first production model of the C-130, was designed for the Tactical Air Command of the U. S. Air Force. Prototypes first flew in 1954 and the first production models became operational with the Tactical Air Command in 1956. More than 200 of the C-130A's are in use by the U. S. Air Force.

The C-130B model is similar in external appearance to the C-130A, but includes several major modifications which increase its capabilities. It can carry more fuel and has higher powered engines.

The first production flight of a C-130B occurred in 1958. Nearly 200 of the C-130B model aircraft are in service with the U. S. Air Force, U. S. Navy, and U. S. Coast Guard. Additional C-130B's are in service with several foreign countries.

The C-130E model is an advanced version of the C-130A and C-130B. It incorporates several structural and system modifications which increase its payload and range. The C-130E's normal configuration includes externally mounted under-wing fuel tanks. The first production C-130E model flew for the first time in 1961. More than 400 C-130E models are in operation with the U. S. Air Force, the U. S. Navy, and some foreign countries. The C-130E model is essentially the same as that certified for commercial usage as one model of the L-100.

The C-130H model is basically the same as the C-130E model, but it has more powerful engines.

A brief description of the structural configuration of the C-130 center wing box follows:

The upper surface of the center wing box is made up of four panels, each of which is 440 inches in span and 20 inches in chord. Each panel is fabricated from machined 7178-T6 extrusions with six integral risers spaced at 3.3 inch intervals. These panels are further stiffened by the installation of three spanwise stringers made from 7178-T6 extruded hat sections spaced at 6.6 inch intervals and installed with riveted attachments except at the spanwise splices.

The spanwise splices are configured as butt joints with an extended leg of a hat section stiffener forming a splice plate and fastened with steel lockbolts.

The lower surface is composed of three panels, each of which is 440 inches in span and 26.7 inches in chord. Each panel is fabricated from machined 7075-T6 plate with extruded 7075-T6 hat section stiffeners located at 5.70 inch spacing. The spanwise splices and attachments for the lower surface are similar to those for the upper surface.

The front and rear beams are composed of 7075-T6 extruded caps with 7075-T6 webs. In the area of the nacelle the webs are 301 full hard, 17-7PH or AM350 stainless steel.

There are discontinuities in the form of cutouts located at W.S. 0.0, 120.5, and 196 left and right of the center line on the upper surface. On the lower surface, cutouts are located at W.S. 120.5 left and right of the center line.

The center wing is identical on both the C-130B and C-130E aircraft except for the configuration of the reinforcing structure surrounding a cutout on the lower surface at W.S. 120.5.

Fatigue tests have been conducted on C-130B and C-130E full scale production specimens which are structurally identical to the wings of the service aircraft. These tests simulated fleet environmental and operational conditions existing at the time of test. The fatigue test

on the C-130B article simulated a Material Airlift Command (MAC) type usage The fatigue test on the C-130E article simulated a Tactical Air Command (TAC) type usage.

A structurally complete C-130B wing and center fuselage were subjected to cyclic loadings calculated to simulate the fatigue effects of typical flight, internal air pressurization, and taxi loads. Each pass of the test load spectrum represents 1,500 hours.

Three major damage items involving the initiation of cracks in the structure of interest in this program occurred during the course of the C-130B wing fatigue test. A brief description of points of interest concerning the test follows:

The first of these damage items occurred near the end of the second pass of the test load spectrum. Numerous fatigue cracks were discovered in the center wing upper surface in the vicinity of W.S. 38 and W.S. 105 left and right. It was necessary to replace the complete center wing upper surface except for the W.S. 220 fitting and several rib caps before continuing fatigue testing.

Reanalysis showed the test loads to be too severe and, before testing was resumed, the taxi and ground-air-ground loads were revised.

The test was then continued with the new center wing upper surface and the revised test loads spectrum.

Pass 4 and 5 of the revised test loads spectrum was a double pass using double the number of cycles for a regular pass of the spectrum.

The second damage item of interest was a repetition of the first and occurred near the end of the double pass 4 and 5. The test was terminated at this point.

The third damage item of interest occurred in the vicinity of the corners of the rectangular cutout located on the lower surface at W.S. 120.5. These cracks were discovered during the teardown inspection following the residual strength test conducted on the specimen after the fatigue test had been terminated. It was determined at the time that these cracks were fatigue oriented.

The results of a correlation analysis of the cracks discussed in the above paragraphs are presented in section V of this report.

The C-130E test article consists of a production C-130E wing and supporting fuselage barrel section. The fuselage reacts all of the applied wing loads by the gear support structure during the landing operation phases and by simulated fuselage inertia loads for flight condition phases.

The cyclic loading fatigue test of the C-130E wing simulates the anticipated operational loads to be experienced by the wing of a C-130E airplane assigned to the Tactical Air Command. These missions, which are based on utilization data, are short range logistics, medium range logistics, long range logistics, proficiency training, and combat training. Each pass of the test load spectrum represents 1,000 hours.

The upper surface panels were removed after six passes of the C-130E TAC test loads spectra had been applied and replaced with a redesigned configuration. Prior to this time cracks had been initiated at one of the three critical areas of interest in this program. This was located at W.S. 38 upper surface. These were small cracks in the skin panels at the last fasteners common to the skin and the center line dry bay access door doubler.

From the above discussion it is seen that the C-130B fatigue test furnished two data points for both the W.S. 38 and W.S. 105 upper surface areas and one data point for the W.S. 120.5 lower surface area. Likewise, the C-130E fatigue test furnished one data point for the W.S. 38 upper surface area.

Lockheed is conducting a fatigue tracking program on the C-130 fleet under contract with Warner Robins Air Materiel Command as a part of the C-130 Aircraft Structural Integrity Program. This program was initiated in early 1968 and is planned to continue through phase-out of the aircraft.

Through an extensive reporting system the USAF supplies operational data relating to usage of the aircraft and structural data relating to crack initiation and propagation for individual aircraft to Lockheed. These data when interpreted in terms of available fatigue test data supply the input necessary to monitor individual C-130's in terms of structural reliability.

SECTION IV

ANALYTICAL DEVELOPMENT DESCRIPTION

This section describes the development of equations for a computer program to facilitate tests for assessing the validity of the method proposed in Reference 1. This computer program correlates service experience information from the C-130 Fatigue Life Monitoring Program in a form for considering the following questions. Is the distribution predicted on the basis of the proposed method applied to C-130 full scale fatigue tests a reasonable representation of the statistics of crack occurrence? Does the C-130 crack initiation data fit a Weibull or log-normal distribution? If the C-130 crack initiation data fits one of these distributions, are the A.F.M.L. selected shape factors good choices?

To aid in answering these questions, the computer program generates the following distributions, the apparent empirical distribution, the theoretical distribution predicted on the basis of full scale fatigue tests, and Weibull and log-normal distributions that provide the best fit to the data. A X^2 statistical test has been devised for each of these distributions.

The apparent distribution is an empirical distribution determined from the data in a manner similar to the determination of mortality tables. The equations for the apparent distribution were initially derived in Reference 2. These equations account for the probable

effect of uncracked aircraft in a reasonable manner without assuming any sort of general form for the cracking distribution. This distribution accounts for the probable effect of the uncracked members of the fleet by the use of conditional probabilities. This is accomplished by the assumption that an uncracked aircraft that was last observed to be uncracked when it had accumulated "T" flight hours is equally likely to be any member of the fleet with a crack initiation time greater than T.

The test distributions are the theoretical distributions predicted by applying the techniques of the proposed method of the results of the C-130 full scale fatigue tests. These techniques assume values for the shape factors of the Weibull and log-normal distributions. The modal values of these distributions are determined from full scale tests by

$$\beta = \left[\frac{1}{n_f} \left(\sum_{i=1}^{n_f} T_i^{\alpha} + (n - n_f) \quad T_{n_f}^{\alpha} \right) \right]^{1/\alpha}$$

for the Weibull distribution and

$$\ln \beta = \frac{1}{n} \sum_{i=1}^{n} \ln T_i$$

for the log normal, where T_i is the i^{th} test failure in equivalent flight hours.

The best fit distributions are simply least squared fits to the apparent distribution. There are eight best fit distributions, four Weibull best fits and four log-normal best fits. For each of these

two types of best fit distributions, there are two distributions with the shape factors assumed in the proposed method, and two with both scale and shape factors determined by the least squares fit technique. In each of these categories there are two distributions. One provides a best fit to the entire population of aircraft and the other only to the first half of this population.

An important factor in developing the techniques for determining the best fit distributions was consideration of computer checkout and running time, and the programming time required. The most mathematically rigorous technique would have been the maximum likelihood estimator (MLE) technique discussed in Reference 3. Solution of the MLE equations requires iterative techniques similar to Newton's method. Although these equations appear reasonably straightforward, experience indicates that the required iterative techniques frequently require significant amounts of programming and computer checkout time before a correct solution can be obtained in a reasonable amount of computer run time. The best fit techniques used have been constructed out of existing well proven computer programs. These techniques are not without precedence because of their resemblance to the common practice of plotting empirical data on probability graph paper and "eyeballing" a straight line fit.

All the best fit distributions are constructed for two sets of data. One set consists of data from the complete fleet or usage group. The other set consists of data from half the fleet or usage group including only the earlier failures. This second set was considered because

predictions of fleet reliability usually depend only on the first portion of the distribution that predicts early failures. Thus it is not necessary that a Weibull or log-normal distribution fit the later failures for the proposed method to be valid.

In planning the reduction of the data from the C-130 fleet, the question arose as to what should be considered a crack at a specified wing station. Should it be from a specified rivet and directed in a specified direction? In considering this question, the distribution for the time of the first of several cracks was examined. It was found that if each of the several cracks were initiated according to Weibull distributions with a single shape factor then the time of the first of these cracks also fit a Weibull distribution with the same shape factor. (In considering this question, it was discovered that the minimum value of each sample of a set of random variables fit a Weibull distribution if each random variable is Weibull with the same shape factor.) Thus, if the assumption of a constant shape factor made in developing the proposed method is correct, it can be applied to the first crack developing at a wing station without considering at which rivet the crack is located or the direction of the crack.

SECTION V

USAGE GROUP DEVELOPMENT

During the course of the Fatigue Life Monitoring Program (FLMP), funded by the Warner Robins Air Materiel Area (WRAMA), the past history of the operational usage of the C-130 fleet has been recontructed for each individual aircraft of the fleet. The development of this historical data is reported in detail in Reference 4, but it is summarized here to illustrate the basic background of information available prior to separating the fleet into usage groups.

Flight logs or records of specific missions flown by each individual aircraft were generally not available for use in the program. If they had been available, the task of collecting and processing this data would have been prohibitively costly. Therefore, the process of reconstructing the past history was necessarily an indirect one, relying to a large extent on the recollection and estimates furnished by experienced personnel in the Air Force. These estimates have been refined in certain specific areas where substantiating data were available such as VGH data reports, Lockheed analyses of mission profiles and damage rates at various bases, and the recently implemented Usage Forms from which detailed current usage data are now becoming available. The overall procedures for estimating the past history include:

- The establishment of the chronological sequence of an individual aircraft's assignment to key Air Force Bases from existing records of possession.
- The establishment by specific time periods of the types of missions flown and the percent utilizations thereof at each key Air Force Base. These estimates were obtained through the various Base Commanders recognizing differences by Using Command and Wing as appropriate.

- The establishment of a set of nine basic mission profiles to represent the basic variety of most missions flown by the aircraft in the fleet by using the information collected from these sources along with similar information from Lockheed Field Service personnel.
- The establishment of the percent of flight time of each aircraft at specific points in time prorated to each mission according to the percentage mission utilizations established for each air base.

The end result of these operations yielded the reconstructed past history for each individual aircraft. This information formed the basis for interpolating the usage data to obtain the percent of time flown in each mission by each aircraft at the time of fatigue crack initiation at the selected locations.

Various refinements, updatings and details of the above procedures are more fully discussed in Reference 4.

A display of the mission utilizations for each individual aircraft revealed a wide pattern of mission combinations flown with several subpatterns existing at the time of crack initiation. It had previously been decided, however, to subdivide the aircraft usage groups into four categories for several reasons:

- Four categories, representing a large part of the usage data, were fairly evident from a review of the mission utilization data.
- Four categories are sufficient to segregate large differences in individual aircraft usage and demonstrate the applicability of the reliability analysis.
- A larger number of categories would increase the amount of computational time and effort while decreasing the statistical reliability of a given category.

The four categories of usage data were obtained by visual inspection of the usage data. For convenience they were given names that coincided with the mission(s) which had the relatively largest amount of flight time in a given mission or group of similar missions. The average mission utilization in each of the four categories was also calculated. A summary of the composition of the usage groups in terms of the nine basic mission profiles is shown in Table I.

Two other distinct categories of usage were noted, but were not used in the subsequent analyses. About a dozen aircraft have been used almost entirely in storm/weather reconnaissance, but they have experienced few fatigue cracks. About fifteen aircraft have been used heavily in the low altitude high speed mission number 9. These latter aircraft have had fatigue cracks to initiate at the earliest recorded aircraft flight time (approximately 1500 hours), but a relatively precise time of crack initiation on these aircraft was difficult to substantiate. In addition, several individual aircraft were not included in any group on the basis that they could not logically be grouped into one or the other of the above four usage groups. For example, airplanes which had spent a significant fraction of their life in the long range mission, usage group I, and were then diverted to usage in a more severely damaging usage group, such as usage group II, were not included in any usage group because, in the context of this study, they are not members of the same statistical population. The net result of these and other specific eliminations reduced the total number of aircraft included in the groups from the original number of 439 C-130B/E aircraft to 366 aircraft. A summary of the number of aircraft assigned to a given category is presented in Table II.

SECTION VI

C-130 TEST RESULT ADJUSTMENT

In Phase IV of the program the Freudenthal-Boeing method is applied to values of the C-130 full scale fatigue test results, which have been adjusted to the load profiles defined for each of the usage groups selected in Phase III. The background pertinent to the calculation of the fatigue endurance of the C-130 structure required in making these adjustments of the test results is discussed in this section.

The usage groups are each composed of those aircraft in the fleet which are reported to have flown a similar combination of the missions contained in the C-130 nine mission profiles. The C-130B and E mission utilization by usage group is shown in Table I.

Nine mission profiles have been established in the C-130 Fatigue Life Monitoring Program to cover the operational usage of the Air Force's C-130 fleet. The utilization of these missions by the C-130 aircraft has been determined for each C-130 base as discussed previously in Section V. Then the aircraft stationed at a certain base are considered to operate according to the mission utilization determined for that base.

The operational usage environment of each of these missions is composed of flight segments and ground segments. Each of these segments is defined by four operational parameters which are considered to be especially significant in defining the configuration of the airplane in that segment and the loads environment. The operational parameters chosen to define the flight segments are altitude, velocity, fuel weight, and cargo weight. For the ground segments they are type of ground event (i.e. taxi, takeoff, run out, landing impact, touch and go, and ground-air-ground), fuel weight, cargo weight, and type of field surface.

The range of values of the operational parameters of altitude, velocity, fuel weight, and cargo weight are divided up into bands. Within each of

the bands, which cover a convenient range of values of the parameter, the effect of the parameter on the fatigue load is treated as constant.

A data block is defined as a unique combination of one band value for each of the four significant parameters from either the flight or ground segments. These data blocks which are used were selected because they represent bands of the parameters which are approximately symmetrical about the expected normal operating speeds and altitudes and they afford coverage over the range of cargo and fuel weights. The totality of data blocks for either the flight or ground segments are composed of the permutations of all the bands of the four significant parameters for that segment.

For a given data block, the loads applicable to it can be determined. The fatigue damage attributed to each data block on a unit time basis can be calculated using these loads. For this study, the fatigue damage in the three structural components of interest are calculated for several quality levels for each of the individual data blocks on a unit time basis.

These values of fatigue damage are calculated using the Palmgren-Miner Theory of Cumulative Fatigue Damage. This theory states that the fatigue damage occurring at a specific combination of mean stress and varying stress is given by the ratio of the number of cycles of this specific load level applied to the structure to the number of cycles required to initiate a crack in the structure. When the summation of these ratios from all load levels applied to the structure is equal to unity then a fatigue crack is assumed to initiate in the structure.

For each mission of the nine mission profiles the utilization of a particular aircraft in terms of the time spent in each data block is defined. So the total fatigue damage that an aircraft is subject to while flying a particular mission is obtained by accumulating the products of time and damage for all data blocks pertinent to that mission.

Values of the fatigue endurance per quality level per usage group are calculated from these values of fatigue damage per mission and the number of flights of each mission flown by an average aircraft in the usage group. These calculated values are used to plot curves of fatigue endurance versus quality level for each usage group.

Then these curves along with the values of quality level corresponding to each structural component considered are used to determine the required adjusted values of the fatigue test results.

SECTION VII

RESULTS OF CORRELATIONS

The results presented in this section of the report consist of the results from Phases I through IV of the study. The results of a review of these comparisons are presented in Section VIII.

Tables I and II lists, respectively, the C-130B and E mission utilizations in each of the usage groups selected and the number of C-130 aircraft assigned to each specific usage group. Table III lists the test endurance results from the full scale fatigue tests on the C-130B and C-130E test articles along with the equivalent E-TAC analysis endurances and the equivalent usage group analysis endurances.

Table IV lists the expected values of the fatigue endurance scatter factors versus reliability, calculated according to the method of Reference 1. Tables V through XIX list the corresponding values of the fatigue endurance predicted for the components of the C-130 structure considered. These values have been calculated by applying the above-mentioned scatter factors to the point estimates of the Weibull characteristic times to crack initiation or to the log-normal median time from the C-130 fatigue test results. The test results used in these computations were based on either the equivalent E-TAC analysis loads or the equivalent loads defined for each of the usage groups as noted on the table.

Figures 1 through 15 show the curves of the distributions of the probabilities of the times to crack initiation developed by considering the service experience data from the whole fleet of C-130B and E aircraft as a single population. Figures 16 through 87 show the curves of the distributions of the probabilities of the times to crack initiation developed using the service experience data obtained from the C-130 aircraft separated into usage groups. Some of these figures show the curves of the Weibull and log-

normal distributions that "best fit" the apparent empirical distribution curves of the C-130 service experience data for each structural component, considering in turn all the aircraft and then half of the aircraft. The other figures show the curves of the Weibull and log-normal theoretical "test" distributions calculated using the method proposed in Reference 1, with values of the C-130 test results based either on the C-130 E-TAC analysis loads or the load cases defined for each usage group.

A summary of the study results is shown in Table XX .

SECTION VIII

DISCUSSION OF COMPARISION PROCEDURES

This section summarizes the review of the comparisons made in this study program.

Comparisons between the estimates of the times to the initiation of the first and the second cracks in the structural details of the C-130 considered in this study and the observed times obtained from service experience are given in Tables XXI through XXX. These comparisons are summarized in Table XXXI.

These results may indicate what level of accuracy can be expected of the use of the method; however they do not isolate the source of the discrepancies. Basically, there are three sources of discrepancies considered in this study. They are:

1. The differences between the fatigue environment of the inservice aircraft and that of the fatigue test specimens.
2. The expected errors.
3. The differences between the proposed theoretical distributions and the true distribution of the time to crack initiation.

The first of these sources of the discrepancies, the factors leading to the differences between the fatigue environments of service and test are not a fault of the proposed method. This is a problem involving the structural fatigue tests and these resulting discrepancies should be removed from the comparisons before they are used in evaluating the adequacy of the proposed method.

The removal of those discrepancies originating from this source involved determining those test results that belong to the same population as the service experience results and those that do not. The maximum and minimum test equivalent times are compared with the empirical distributions. The results of these comparisons are summarized in Tables XXXII and XXXIII. These results indicate that all the adjusted test results and all of the unadjusted test results

except that for wing station 120.5 on Group 4 aircraft most likely do not belong to the corresponding populations of service experience. In addition, there are a few aircraft included in the whole fleet comparisons shown in Table XXI that do not fit into any of the usage groups selected. The service data indicates that the usage of these aircraft has been so severe that cracks are initiating in them much sooner than in the rest of the fleet. For this reason, these aircraft have been omitted from all four usage groups and should be considered as part of another population. If the data pertaining to the above mentioned aircraft are eliminated from the data contributing to Table XXXI, the remaining results are given in Table XXXIV .

The second source of the discrepancies, the expected errors, result from the following random processes involved in the calculation of a prediction of time to crack initiation.

The first random process to be considered is the selection of the scale parameter on the basis of a small sample size, i.e., the limited number of full scale fatigue test results. The values of the scale parameters used in the study are shown in Table XXXV. Those values used in the "Best Fit" distributions were calculated from the "Best Fit" equations discussed in Section IV, and those values used in the "Test" distributions were determined using the method of Reference 1. The percent differences between these C-130 scale parameter values and those determined from the apparent empirical curves are given in Table XXXVI .

A second random process is the process of development of the first crack in the fleet. The proposed method is designed to insure that the probability of these random processes resulting in an unconservative estimate is small. This causes a conservative estimate of the expected time to crack initiation to be calculated; so that the predicted endurance is less than the expected endurance.

The exact expected values of the scatter factors and the predicted time to the initiation of the first crack in the C-130 wing, computed

versus reliability for three values of the Weibull shape parameter discussed in Reference 1, are shown in Tables XXXVII and XXXVIII. The derivation of the equations used in these calculations is based on the Weibull distribution. This derivation is shown in the Appendix. The values of the shape parameters used are the upper bound value proposed, the maximum likelihood estimator value, and the two-ordered failure estimated value. The percent differences between the conservative expected values of Tables V through XIX, calculated according to the method of Reference 1, and the exact expected values discussed above are given in Table XXXIX .

The third source of the discrepancies, the differences between the true distribution of time to crack initiation and the proposed theoretical distributions, will be considered as two points.

The first concerns the adequacy of the values of the shape parameters proposed by Reference 1. The C-130 related, empirical shape parameters as determined from the "Best Fit" distributions are given in Table XXXX . The percent differences between the values of the shape parameter proposed by Reference 1 and these C-130 empirical values are shown in Table XXXXI . In addition, the exact expected values of the time to initiation of the first crack in the C-130 wing versus reliability for these same C-130 empirical values of the Weibull shape parameter were calculated using the equations derived in the Appendix based on the Weibull distribution. These values are presented in Table XXXXII.

The second point concerns the relative adequacy of the log-normal and Weibull distributions to predict the true distribution of times to crack initiation in the structure of an aircraft from a fleet. The values of the times to the initiation of cracks in several C-130 center wing structural locations taken for selected percentiles from the curves of Figures 1 through 87 are shown in Table XXXXIII . The percent differences between these times to crack initiation and those observed empirical values taken from the apparent empirical distributions are given in Table XXXXIV . In addition, the percent

differences in times to crack initiation between the "Best Fit" distributions computed using the proposed values of the shape parameter and those computed using a value of the shape parameter determined by the Best Fit equations are given in Table XXXXV . The number of these values of percent differences which are greater than 10 percent is shown in Table XXXXVI . The number which have a value greater than 20 percent is shown in Table XXXXVII. These tables include values corresponding to both the log-normal and Weibull distributions for purposes of comparison.

SECTION IX

DISCUSSION OF RESULTS

This section discusses the results of the review of the comparisons made in this study for the purpose of evaluating the probabilistic approach to structural fatigue endurance prediction discussed in Reference 1 . The details of this review are described in Section VIII .

Three possible sources of discrepancies between the predicted and observed values of fatigue endurance are discussed in Section VIII . They are the differences between fatigue environment of inservice aircraft and test specimens, the expected errors, and the differences between the theoretical and the true distributions. The results of the review relating to these sources will be discussed in this section.

The range of the percent differences between the C-130 fatigue endurance predictions calculated using the method of Reference 1 and the observed times to crack initiation are quite broad for the cases considered in this study. These differences for the weakest fleet member vary from -89 to 180 percent for the Weibull distribution based predictions and from -81 to 308 percent for log-normal distribution based predictions. The differences for the 2nd weakest fleet member vary from -82 to 144 percent for the Weibull distribution based predictions and from -77 to 122 percent for the log-normal distribution based predictions.

The fatigue environment differences between the C-130's test and service affect these differences between predicted and observed values. Therefore, when the data from the test results not belonging to the same population as the service experience and also the data from those aircraft that have had more severe service usage than the rest of the fleet have been eliminated, then the range of percent differences is narrowed down somewhat. This censored range varies for the weakest fleet member from -79 to -35 percent

for the Weibull Distribution based predictions and from -66 to -5 percent for the log-normal distribution based predictions; and for the 2nd weakest fleet member from -67 to 20 percent for the Weibull distribution based predictions and from -59 to -7 percent for the log-normal distribution based predictions. The Weibull distribution based predictions are generally more conservative than are the log-normal based predictions.

The expected errors include the inaccuracies inherent in choosing the value of the scale parameters from a very limited number of test points. The differences between the scale parameter values calculated from the C-130 fatigue test results with the maximum likelihood estimating procedure and the values obtained from the empirical curves of the C-130 service results for the whole fleet is about 1 percent for the Weibull distribution related parameter and varies from -3 to 24 percent for the log-normal distribution related parameter. The range of the corresponding differences based on comparisons of these calculated values with values chosen from the empirical curves for the several usage groups is between -30 and 59 percent for the Weibull distribution parameters, and -28 and 69 percent for the log-normal distribution parameters. These comparisons are contained in Table XXXVI under the heading "Test Distribution". In addition, the differences between the scale parameter values calculated for the "Best Fit" distributions for both the cases of assumed and empirical shape parameters and the same empirical values as used above are shown on the same table. It is seen from the Table XXXV that values of empirical scale parameters have not been given for every case; this is because the curve of the empirical distribution does not extend high enough to allow such a value to be chosen for these cases.

Another of the expected errors is the conservatism built into the estimate of the time to crack initiation. Table XXXIX furnishes an estimate of the level of this conservatism for a prediction of the fatigue endurance of the weakest member of the C-130 fleet

with the Weibull distribution. From this table it is seen that this estimate varies from a high of about 33 percent to a low of about 21 percent based on the maximum likelihood estimated value of α , i.e. $\alpha = 4.139$. Using this estimate the censored percentage differences shown on Table XXXIV can be modified somewhat. When an approximate level of conservatism of 20% is considered these modified censored results for the Weibull distribution have a range which varies from -59 to -15 percent for the weakest fleet member.

The third of the possible sources of discrepancies mentioned is the differences between the proposed theoretical distributions and the true distributions. One of the points here involves the adequacy of the proposed shape parameters. Table XXXX shows that the values of the shape parameters, 4.0 for the Weibull distribution and 0.322 for the log-normal distribution, proposed by Reference 1 , lie between the values of the empirical shape parameters from the complete data for the whole fleet and for the usage groups. The value of the log-normal shape parameter shown is referenced to the logarithm to the base e instead of to the base 10 as given in Reference 1. The values of the Weibull shape parameter for the complete data from the whole fleet range between 2.6 to 3.6. Those for the usage groups range between 5.7 to 16.9. The values of log-normal shape parameters for the complete data from the whole fleet range between 0.42 to 0.74. Those for the usage groups range between 0.11 to 0.32. Therefore the proposed shape parameters for both the Weibull and log-normal distributions represent too little scatter for the whole fleet sets and too much scatter for the usage group sets. This result follows the trend expected of more scatter inherent in the whole fleet data than in the usage group data.

The empirical values of the Weibull shape parameter are used to calculate the exact expected values of time to crack initiation for the weakest fleet member based on the Weibull distribution.

This was done in order to see what the effect on the calculated results would be. The results are given in Table XXXXII . When these values are compared with the lowest observed times to crack initiation given on Tables V through XIX it is seen that the results are scattered and inconclusive.

The last major point considered concerns the relative adequacy of the Weibull and the log-normal distributions to predict the true distribution of times to crack initiation in a fleet. The relative differences between the calculated and empirical distributions of the C-130 times to crack initiation for both the Weibull and log-normal distributions curves are shown for several percentiles in Table XXXXIV and are summarized in Tables XXXXVI and XXXXVII . The theoretical test distribution points are more than 10 percent different from the corresponding empirical distribution points in 6 out of 9 cases considered for both the Weibull and log-normal distributions for the whole fleet data. Similarily, for the usage group data the Weibull test distribution is more than 10 percent different in 23 out of 40 cases and the log-normal test distribution in 21 out of 40 cases. The same points of the whole fleet data for both the Weibull and log-normal distributions are more than 20% different in 4 our of 9 cases and the usage group data is more than 20% different in 14 out of 40 cases for the Weibull distribution and 15 out of 40 cases for the log-normal distribution. These differences between the theoretical test and the empirical distribution curves for the whole fleet sets range between -22 and 40 percent for the Weibull distributions and -24% and 70% for the log-normal distributions. These differences for the usage group sets range between -33% and 8% for the Weibull distributions and between -19 and 18 percent for the log-normal distributions.

The calculation of the fatigue damage values required in the adjustment of the test endurance results to correspond to the C-130 service group usage was based on the loads developed from the C-130 B and E dynamic response airplane data and also from the C-130 Taxi-Air-Ground Loads program (TAG) data. This program consists of instrumenting and monitoring a C-130 in-service aircraft over approximately a 500 hour period for the purpose of verifying and refining the C-130 fatigue loads spectra. The endurances shown on Table III for Wing Stations 38 and 105 on the center wing upper surfaces are seen to be unconservative when compared with the observed empirical results. These results follow the trend indicated by the C-130 Fatigue Life Monitoring Program (FLMP) reports. The results calculated for Wing Station 120.5 on the lower surface are inconsistent with the results from the other stations mentioned above, while the current FLM reports show that this station should have the same trend as these other stations.

SECTION X

CONCLUSIONS AND RECOMMENDATIONS

This program has attempted to evaluate objectively the method proposed in AFML-69-65, Reference 1, for using a probabilistic approach with fatigue test results to predict the structural fatigue endurance of an aircraft within a fleet of aircraft. The following conclusions have resulted from this program.

1. This method when used with test results which adequately reflect the service conditions of the fleet has been shown to have considerable promise with respect to the current state of the art for the prediction of the time to fatigue crack initiation in the structure of an in-service aircraft. This method gives the analyst the capability of estimating the time to the initiation of the first crack based on certain probability considerations. However, further development and evaluation of the method using data from other aircraft programs is warranted.

2. The average censored values predicted for the C-130 fatigue endurance by the method of Reference 1 are approximately 60 percent conservative for the Weibull distributive and 37 percent conservative for the log-normal distribution as compared with the values observed from the service experience of the C-130 fleet.

3. The estimate of the time to first crack initiation made using the method of AFML-TR-69-65 (Reference 1) is conservative by approximately 20 to 33 percent as compared with an "exact" estimate for the C-130 cases considered in this study.

4. The values of the shape parameters proposed by Reference 1 generally lie between the values of the empirical C-130 shape parameters chosen by the "Best Fit" technique for the whole fleet cases and for the usage group cases.

5. There appears to be very little difference between the ability of the theoretical Weibull distribution and the log-normal distribution to predict the true distribution of the time to crack initiation in a structure of an aircraft in a fleet.

It is recommended that a modification of the Freudenthal-Boeing method of Reference 1 be considered. This modification involves using the data from the initial service fatigue damage occurrences in addition to the fatigue test results to update the fatigue endurance predictions, which according to the present method are based on the fatigue test results alone. This proposed modification would seem to furnish an improvement in the expected accuracy of the predictions as a result of the following:

1. Fatigue damage resulting from fleet usage in service is more representative of the actual fleet environment than the fatigue damage items resulting from tests. Also, the fatigue endurance predictions based on this data are significant because the initial fatigue cracks should come from "Lead the Fleet" aircraft which represent a cross-section of the fleet's structural and environmental conditions.

2. The use of this service-related data would increase the number of data points on which the predictions are based. This is true even when there is only one fatigue crack occurrence from the service fleet because the maximum likelihood estimate equations which are used in the study include the significance of the flight hours on the uncracked aircraft.

SECTION XI

REFERENCES

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TABLE I

C-130 B/E MISSION UTILIZATION
BY USAGE GROUP

BASIC (9) MISSION	PERCENT FLIGHT HOUR UTILIZATION — USAGE GROUPS				BASIC MISSION TYPE
	I	II	III	IV	
1	-	-	9.0	$\boxed{10.0}$	Proficiency Training
2	14.0	8.5	8.5	$\boxed{37.0}$	Basic Training
3	-	$\boxed{30.0}$	7.5	4.0	Shuttle
4	22.0	$\boxed{25.0}$	25.0	17.5	Short Range Logistics
5	$\boxed{61.0}$	22.5	25.0	25.0	Long Range Logistics
6	3.0	14.0	$\boxed{9.5}$	6.5	Airdrop
7	-	-	$\boxed{-}$	-	Storm Recon.
8	-	-	$\boxed{8.0}$	-	Combat Training
9	-		$\boxed{7.5}$		Low Level
Totals	100%	100%	100%	100%	

I. Long Range Logistics

II. Shuttle & Short Range Logistics

III. Combat Training & Low Level Flights

IV. Basic & Proficiency Training

The entries enclosed in a box represent the missions receiving emphasis in a given category.

TABLE II

NUMBER OF AIRCRAFT ASSIGNED
TO SPECIFIC USAGE GROUPS

USAGE GROUP	NUMBER OF AIRCRAFT C-130B	C-130E	TOTAL C-130B/E
I	13	89	102
II	69	52	121
III	0	92	92
IV	26	25	51
Totals	108	258	366

TABLE III

C-130 FATIGUE TEST RESULTS

WING STATION	TEST	TEST ENDURANCE	K_T	EQUIVALENT E-TAC ANALYSIS ENDURANCE	USAGE GROUP	EQUIVALENT USAGE GROUP ANALYSIS ENDURANCE
IN.				HOURS		HOURS
38 U.S.	B-MAC Original Spectrum	2,000	5.3	13,300	1	46,200
					2	26,400
					3	35,100
					4	33,900
38 U.S.	B-MAC Revised Spectrum	6,860	6.0	7,800	1	28,300
					2	15,600
					3	20,700
					4	20,700
38 U.S.	E-TAC	6,000	6.7	5,400	1	19,000
					2	10,200
					3	13,700
					4	13,700
105 U.S.	B-MAC Original Spectrum	2,010	6.0	9,300	1	40,400
					2	22,000
					3	29,300
					4	29,300
105 U.S.	B-MAC Revised Spectrum	6,930	7.0	5,520	1	24,200
					2	12,800
					3	17,700
					4	17,700
121 L.S.	B-MAC Combined Spectrum	11,510	8.0	5,640	1	11,700
					2	2,660
					3	4,680
					4	8,200

TABLE IV

EXPECTED VALUES OF SCATTER FACTOR

Scatter Factor vs. Reliability For Test Sample Sizes of 1, 2, or 3 Specimens For Fleet Size of 432 Airplanes (Ref.: Tables IX, X, XIII, XIV of AFML-TR-69-65)															
Weibull Distribution								Log Normal Distribution							
Weakest Fleet Member				2nd Weakest Fleet Member				Weakest Fleet Member				2nd Weakest Fleet Member			
$\overline{R}$	Test Sample Size			$\overline{R}$	Test Sample Size			$\overline{R}$	Test Sample Size			$\overline{R}$	Test Sample Size		
	1	2	3		1	2	3		1	2	3		1	2	3
.368	5.88	5.60	5.43												
.500	6.44	6.14	5.95	.50	4.90	4.68	4.53	.500	4.40	3.76	3.52	.50	3.84	3.28	3.08
.507	6.48	6.18	5.98												
								.600	4.56	3.89	3.65				
.750	8.03	7.65	7.40	.75	5.66	5.40	5.23	.750	4.76	4.06	3.81	.75	4.11	3.51	3.29
.900	10.55	10.06	9.74	.90	6.67	6.36	6.16	.900	5.19	4.42	4.15	.90	4.41	3.77	3.54
.950	12.35	11.77	11.4	.95	7.37	7.03	6.80	.950	5.52	4.71	4.42	.95	4.57	3.90	3.66
.980	15.58	14.85	14.4												
.990	18.53	17.71	17.1					.990	6.31	5.38	5.05				
.999	33.10	31.56	30.5												

[illegible]

EXPECTED VALUES OF SCATTER FACTOR

Scatter Factor vs. Reliability

For Test Sample Size of 1, 2, or 3 Specimens
For Group 1 Size of 102 Airplanes

(Ref.: Tables IX, X, XIII, XIV of AFML-TR-69-65)

Weibull Distribution								Log Normal Distribution							
Weakest Fleet Member				2nd Weakest Fleet Member				Weakest Fleet Member				2nd Weakest Fleet Member			
$\bar{R}$	Test Sample Size			$\bar{R}$	Test Sample Size			$\bar{R}$	Test Sample Size			$\bar{R}$	Test Sample Size		
	1	2	3		1	2	3		1	2	3		1	2	3
.368	4.12	3.93	3.81												
.500	4.52	4.31	4.17	.50	3.47	3.31	3.20	.50	3.81	3.25	3.05	.50	3.27	2.79	2.62
.507	4.55	4.33	4.19												
								.60	3.92	3.34	3.13				
.750	5.63	5.37	5.20	.75	3.99	3.81	3.68	.75	4.16	3.55	3.33	.75	3.53	3.01	2.82
.900	7.80	7.06	6.83	.90	4.75	4.53	4.38	.90	4.55	3.88	3.64	.90	3.81	3.25	3.05
.950	8.66	8.26	7.99	.95	5.23	4.99	4.83	.95	4.92	4.20	3.94	.95	3.95	3.37	3.16
.980	10.93	10.42	10.09												
.990	13.03	12.43	12.03					.99	5.63	4.80	4.50				
.999	23.22	22.14	21.43												

TABLE IV (CONTINUED)

EXPECTED VALUES OF SCATTER FACTOR

Scatter Factor vs. Reliability

For Test Sample Size of 1, 2, or 3 Specimens
For Group 2 Size of 121 Airplanes

(Ref.: Tables IX, X, XIII, XIV of AFML-TR-69-65)

Weibull Distribution								Log Normal Distribution							
Weakest Fleet Member				2nd Weakest Fleet Member				Weakest Fleet Member				2nd Weakest Fleet Member			
$\bar{R}$	Test Sample Size			$\bar{R}$	Test Sample Size			$\bar{R}$	Test Sample Size			$\bar{R}$	Test Sample Size		
	1	2	3		1	2	3		1	2	3		1	2	3
.368	4.27	4.07	3.94												
.500	4.68	4.47	4.32	.50	3.63	3.46	3.35	.50	3.87	3.30	3.10	.50	3.34	2.85	2.67
.507	4.71	4.49	4.34												
								.60	3.99	3.41	3.19				
.750	5.83	5.56	5.38	.75	4.17	3.98	3.85	.75	4.21	3.59	3.37	.75	3.60	3.07	2.88
.900	7.67	7.31	7.08	.90	4.96	4.73	4.58	.90	4.61	3.94	3.69	.90	3.89	3.32	3.11
.950	8.97	8.56	8.28	.95	5.48	5.22	5.06	.95	4.99	4.25	3.99	.95	4.03	3.44	3.22
.980	11.32	10.80	10.45												
.990	13.50	12.87	12.46					.99	5.70	4.86	4.56				
.999	24.05	22.94	22.20												

TABLE IV (CONTINUED)

EXPECTED VALUES OF SCATTER FACTOR

Scatter Factor vs. Reliability

For Test Sample Size of 1, 2, or 3 Specimens
For Group 3 Size of 92 Airplanes

(Ref.: Tables IX, X, XIII, XIV of AFML-TR-69-65)

Weibull Distribution								Log Normal Distribution							
Weakest Fleet Member				2nd Weakest Fleet Member				Weakest Fleet Member				2nd Weakest Fleet Member			
$\bar{R}$	Test Sample Size			$\bar{R}$	Test Sample Size			$\bar{R}$	Test Sample Size			$\bar{R}$	Test Sample Size		
	1	2	3		1	2	3		1	2	3		1	2	3
.368	4.00	3.82	3.70												
.500	4.39	4.19	4.05	.50	3.38	3.23	3.12	.50	3.75	3.20	3.00	.50	3.23	2.76	2.59
.507	4.41	4.21	4.07												
								.60	3.86	3.29	3.09				
.750	5.47	5.21	5.05	.75	3.90	3.72	3.60	.75	4.10	3.50	3.28	.75	3.49	2.98	2.79
.900	7.19	6.86	6.63	.90	4.64	4.42	4.28	.90	4.50	3.84	3.60	.90	3.77	3.21	3.01
.950	8.41	8.02	7.76	.95	5.10	4.87	4.71	.95	4.85	4.14	3.88	.95	3.91	3.33	3.13
.980	10.61	10.12	9.79												
.990	12.65	12.07	11.68					.99	5.58	4.76	4.46				
.999	22.54	21.50	20.81												

TABLE IV (CONTINUED)

EXPECTED VALUES OF SCATTER FACTOR

Scatter Factor vs. Reliability For Test Sample Size of 1, 2, or 3 Specimens For Group 4 Size of 51 Airplanes (Ref.: Tables IX, X, XIII, XIV of AFML-TR-69-65)															
Weibull Distribution								Log Normal Distribution							
Weakest Fleet Member				2nd Weakest Fleet Member				Weakest Fleet Member				2nd Weakest Fleet Member			
$\bar{R}$	Test Sample Size			$\bar{R}$	Test Sample Size			$\bar{R}$	Test Sample Size			$\bar{R}$	Test Sample Size		
	1	2	3		1	2	3		1	2	3		1	2	3
.368	3.47	3.31	3.20												
[illegible]	3.30	3.63	3.51	.50	3.04	2.90	2.81	.50	3.46	2.95	2.77	.50	3.08	2.63	2.46
.507	3.83	3.65	3.53												
								.60	3.62	3.09	2.89				
.750	4.74	4.52	4.37	.75	3.50	3.34	3.23	.75	3.84	3.28	3.07	.75	3.33	2.84	[illegible]
.900	6.23	5.94	5.75	.90	4.18	3.98	3.86	.90	4.29	3.66	3.43	.90	3.60	3.07	2.89
.950	7.29	6.95	6.73	.95	4.57	4.36	4.22	.95	4.55	3.88	3.64	.95	3.73	3.15	2.98
.980	9.20	8.77	8.49												
.990	10.97	10.46	10.12					.99	5.34	4.56	4.27				
.994	19.54	18.54	18.04												

TABLE V

EXPECTED AND OBSERVED VALUES OF FATIGUE ENDURANCE FOR C-130 CENTER WING STATION 38 ON UPPER SURFACE

Theoretical Prediction of Safe-Life vs. Reliability (Ref. Tables IX, X, XIII, XIV of AFML-TR-69-65)							
Weibull Distribution				Log Normal Distribution			
Weakest Fleet Member		2nd Weakest Fleet Member		Weakest Fleet Member		2nd Weakest Fleet Member	
$\overline{R}$	Flight Hours	$\overline{R}$	Flight Hours	$\overline{R}$	Flight Hours	$\overline{R}$	Flight Hours
.368	1,920						
.500	1,760	.50	2,310	.500	2,340	.50	2,680
.507	1,750			.600	2,260		
.750	1,410	.75	2,000	.750	2,160	.75	2,500
.900	1,070	.90	1,700	.900	1,990	.90	2,350
.950	917	.95	1,540	.950	1,860	.95	2,250
.980	726						
.990	611			.990	1,630		
.999	343						

Lowest Observed Times to Crack Initiation (From C-130 Service Experience Data)
Flight Hours
2,272
2,778
2,884
2,896

TABLE VI

EXPECTED AND OBSERVED VALUES OF FATIGUE ENDURANCE FOR C-130 B/E CENTER WING STATION 105 ON UPPER SURFACE

Theoretical Prediction of Safe-Life vs. Reliability (Ref.: Tables IX, X, XIII, XIV of AFML-TR-69-65)							
Weibull Distribution				Log Normal Distribution			
Weakest Fleet Member		2nd Weakest Fleet Member		Weakest Fleet Member		2nd Weakest Fleet Member	
$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours
.368	1,440						
.500	1,310	.50	1,720	.500	1,910	.50	2,180
.567	1,300			.600	1,840		
.750	1,050	.75	1,490	.750	1,760	.75	2,040
.900	800	.90	1,270	.900	1,620	.90	1,900
.950	680	.95	1,150	.950	1,520	.95	1,840
.980	540						
.990	450			.990	1,330		
.999	250						

Lowest Observed Times to Crack Initiation (From C-130 Service Experience Data)
Flight Hours
468
1,887
3,295
3,467

TABLE VII

EXPECTED AND OBSERVED VALUES OF FATIGUE ENDURANCE FOR C-130 B/E CENTER WING STATION 121 ON LOWER SURFACE

Theoretical Prediction of Safe Life vs. Reliability (Ref.: Tables IX, X, XIII, XIV of AFML-TR-69-65)							
Weibull Distribution				Log Normal Distribution			
Weakest Fleet Member		2nd Weakest Fleet Member		Weakest Fleet Member		2nd Weakest Fleet Member	
$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours
.368	960						
.500	880	.50	1,150	.500	1,280	.50	1,470
.507	870			.600	1,240		
.750	700	.75	1,000	.750	1,180	.75	1,370
.900	530	.90	850	.900	1,090	.90	1,280
.950	460	.95	760	.950	1,020	.95	1,230
.980	360						
.990	300			.990	890		
.999	170						

Lowest Observed Times to Crack Initiation (From C-130 Service Experience Data)
Flight Hours
990
1,347
1,362
1,387

TABLE VIII

EXPECTED AND OBSERVED VALUES OF FATIGUE ENDURANCE
FOR C-130 B/E CENTER WING STATION 38 ON UPPER SURFACE
FOR GROUP 1

Theoretical Prediction of Fatigue Endurance vs. Reliability (Ref.: Tables IX, X, XIII, XIV of AFML-TR-69-65)							
Weibull Distribution				Log Normal Distribution			
Weakest Fleet Member		2nd Weakest Fleet Member		Weakest Fleet Member		2nd Weakest Fleet Member	
$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours
.368	2,745						
.500	2,508	.500	3,268	.50	2,703	.50	3,147
.507	2,496			.60	2,634		
.750	2,011	.75	2,842	.75	2,476	.75	2,923
.900	1,531	.90	2,388	.90	2,265	.90	2,703
.950	1,309	.95	2,165	.95	2,092	.95	2,609
.980	1,036						
.990	869			.99	1,832		
.999	488						

Lowest Observed Times to Crack Initiation (From C-130 Service Experience Data)
Flight Hours
6,230
6,595
6,688
6,700

TABLE VIII (CONTINUED)

EXPECTED AND OBSERVED VALUES OF FATIGUE ENDURANCE
FOR C-130 B/E CENTER WING STATION 38 ON UPPER SURFACE
FOR GROUP 1

WITH TEST RESULTS ADJUSTED FOR GROUP'S USAGE

Theoretical Prediction of Fatigue Endurance vs. Reliability (Ref.: Tables IX, X, XIII, XIV of AFML-TR-69-65)							
Weibull Distribution				Log Normal Distribution			
Weakest Fleet Member		2nd Weakest Fleet Member		Weakest Fleet Member		2nd Weakest Fleet Member	
$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours
.368	9,580						
.500	8,753	.50	11,406	.50	9,567	.50	11,137
.507	8,711			.60	9,323		
.750	7,019	.75	9,918	.75	8,763	.75	10,348
.900	5,344	.90	8,333	.90	8,016	.90	9,567
.950	4,568	.95	7,557	.95	7,406	.95	9,234
.980	3,617						
.990	3,034			.99	6,484		
.999	1,703						

Lowest Observed Times to Crack Initiation (From C-130 Service Experience Data)
Flight Hours
6,230
6,595
6,688
6,700

TABLE IX

EXPECTED AND OBSERVED VALUES OF FATIGUE ENDURANCE FOR C-130 B/E CENTER WING STATION 105 ON UPPER SURFACE FOR GROUP 1

Theoretical Prediction of Fatigue Endurance vs. Reliability

(Ref.: Tables IX, X, XIII, XIV of AFML-TR-69-65)

Weibull Distribution				Log Normal Distribution			
Weakest Fleet Member		2nd Weakest Fleet Member		Weakest Fleet Member		2nd Weakest Fleet Member	
$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours
.368	2,049						
.500	1,868	.50	2,433	.50	2,205	.50	2,568
.507	1,860			.60	2,145		
.750	1,499	.75	2,113	.75	2,018	.75	2,380
.900	1,141	.90	1,777	.90	1,847	.90	2,205
.950	975	.95	1,614	.95	1,706	.95	2,126
.980	773						
.990	648			.99	1,493		
.999	364						

Lowest Observed Times to Crack Initiation

(From C-130 Service Experience Data)

Flight Hours
6,328
6,335
6,518
6,817

TABLE IX (CONTINUED)

EXPECTED AND OBSERVED VALUES OF FATIGUE ENDURANCE FOR C-130 B/E CENTER WING STATION 105 ON UPPER SURFACE FOR GROUP 1

TEST RESULTS ADJUSTED FOR GROUP'S USAGE

Theoretical Prediction of Fatigue Endurance vs. Reliability (Ref.: Tables IX, X, XIII, XIV of AFML-TR-69-65)							
Weibull Distribution				Log Normal Distribution			
Weakest Fleet Member		2nd Weakest Fleet Member		Weakest Fleet Member		2nd Weakest Fleet Member	
$\bar{\bar{R}}$	Flight Hours	$\bar{\bar{R}}$	Flight Hours	$\bar{\bar{R}}$	Flight Hours	$\bar{\bar{R}}$	Flight Hours
.368	8,906						
.500	8,121	.50	10,574	.50	9,600	.50	11,183
.507	8,083			.60	9,341		
.750	6,518	.75	9,186	.75	8,789	.75	10,365
.900	4,958	.90	7,726	.90	8,041	.90	4,600
.950	4,237	.95	7,014	.95	7,429	.95	9,258
.980	3,359						
.990	2,816			.99	6,500		
.999	1,581						

Lowest Observed Times to Crack Iniation (From C-130 Service Experience Data)
Flight Hours
6,328
6,335
6,518
6,817

TABLE X

EXPECTED AND OBSERVED VALUES OF FATIGUE ENDURANCE
FOR C-130 B/E CENTER WING STATION 121 ON LOWER SURFACE
FOR GROUP 1

Theoretical Prediction of Fatigue Endurance vs. Reliability (Ref.: Tables IX, X, XIII, XIV of AFML-TR-69-65)							
Weibull Distribution				Log Normal Distribution			
Weakest Fleet Member		2nd Weakest Fleet Member		Weakest Fleet Member		2nd Weakest Fleet Member	
$\bar{R}$	Flight Hours	R	Flight Hours	$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours
.368	1,354						
.500	1,234	.50	1,608	.50	1,465	.50	1,706
.507	1,226			.60	1,423		
.750	991	.75	1,398	.75	1,341	.75	1,581
.900	754	.90	1,175	.90	1,226	.90	1,465
.950	644	.95	1,067	.95	1,134	.95	1,413
.980	511						
.990	428			.99	991		
.999	240						

Lowest Observed Times to Crack Initiation (From C-130 Service Experience Data)
Flight Hours
6,024
6,094
6,132
6,189

TABLE X (CONTINUED)

EXPECTED AND OBSERVED VALUES OF FATIGUE ENDURANCE
FOR C-130 B/E CENTER WING STATION 121 ON LOWER SURFACE
FOR GROUP 1

TEST RESULTS ADJUSTED FOR GROUP'S USAGE

Theoretical Prediction of Fatigue Endurance vs. Reliability (Ref.: Tables IX, X, XIII, XIV of AFML-TR-69-65)							
Weibull Distribution				Log Normal Distribution			
Weakest Fleet Member		2nd Weakest Fleet Member		Weakest Fleet Member		2nd Weakest Fleet Member	
$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours
.368	2,840						
.500	2,588	.50	3,372	.50	3,071	.50	3,578
.507	2,571			.60	2,985		
.750	2,078	.75	2,932	.75	2,813	.75	3,314
.900	1,581	.90	2,463	.90	2,571	.90	3,071
.950	1,351	.95	2,237	.95	2,378	.95	2,962
.980	1,070						
.990	898			.99	2,078		
.999	504						

Lowest Observed Times to Crack Initiation (From C-130 Service Experience Data)
Flight Hours
6,024
6,094
6,132
6,189

TABLE XI

EXPECTED AND OBSERVED VALUES OF FATIGUE ENDURANCE
FOR C-130 B/E CENTER WING STATION 38 ON UPPER SURFACE
FOR GROUP 2

Theoretical Prediction of Fatigue Endurance vs. Reliability (Ref.: Tables IX, X, XIII, XIV of AFML-TR-69-65)							
Weibull Distribution				Log Normal Distribution			
Weakest Fleet Member		2nd Weakest Fleet Member		Weakest Fleet Member		2nd Weakest Fleet Member	
$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours
.368	2,654						
.500	2,421	.50	3,122	.50	2,659	.50	3,088
.507	2,410			.60	2,584		
.750	1,944	.75	2,716	.75	2,446	.75	2,863
.900	1,477	.90	2,283	.90	2,234	.90	2,651
.950	1,263	.95	2,067	.95	2,066	.95	2,560
.980	1,001						
.990	839			.99	1,808		
.999	471						

Lowest Observed Times to Crack Initiation (From C-130 Service Experience Data)
Flight Hours
2,778
2,884
3,295
3,598

TABLE XI (CONTINUED)

EXPECTED AND OBSERVED VALUES OF FATIGUE ENDURANCE FOR C-130 B/E CENTER WING STATION 38 ON UPPER SURFACE FOR GROUP 2

TEST RESULTS ADJUSTED FOR GROUP'S USAGE

Theoretical Prediction of Fatigue Endurance vs. Reliability (Ref.: Tables IX, X, XIII, XIV of AFML-TR-69-65)							
Weibull Distribution				Log Normal Distribution			
Weakest Fleet Member		2nd Weakest Fleet Member		Weakest Fleet Member		2nd Weakest Fleet Member	
$\bar{\bar{R}}$	Flight Hours	$\bar{\bar{R}}$	Flight Hours	$\bar{\bar{R}}$	Flight Hours	$\bar{\bar{R}}$	Flight Hours
.368	5,266						
.500	4,803	.50	6,194	.50	5,206	.50	6,045
.507	4,781			.60	5,060		
.750	3,857	.75	5,390	.75	4,789	.75	5,604
.900	2,931	.90	4,531	.90	4,374	.90	5,190
.950	2,506	.95	4,101	.95	4,045	.95	5,012
.980	1,986						
.990	1,665						
.999	935			.99	3,539		

Lowest Observed Times to Crack Initiation
(From C-130 Service Experience Data)

Flight Hours
2,778
2,884
3,295
3,598

TABLE XII

EXPECTED AND OBSERVED VALUES OF FATIGUE ENDURANCE
FOR C-130 B/E CENTER WING STATION 105 ON UPPER SURFACE
FOR GROUP 2

Theoretical Prediction of Fatigue Endurance vs. Reliability (Ref.: Tables IX, X, XIII, XIV of AFML-TR-69-65)							
Weibull Distribution				Log Normal Distribution			
Weakest Fleet Member		2nd Weakest Fleet Member		Weakest Fleet Member		2nd Weakest Fleet Member	
$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours
.368	1,978						
.500	1,801	.50	2,327	.50	2,171	.50	2,514
.507	1,793			.60	2,101		
.750	1,448	.75	2,023	.75	1,996	.75	2,334
.900	1,102	.90	1,702	.90	1,819	.90	2,158
.950	941	.95	1,543	.95	1,686	.95	2,083
.980	746						
.990	626			.99	1,474		
.999	351						

Lowest Observed Times to Crack Initiation (From C-130 Service Experience Data)
Flight Hours
3,295
3,732
3,818
3,888

TABLE XII (CONTINUED)

EXPECTED AND OBSERVED VALUES OF FATIGUE ENDURANCE
FOR C-130 B/E CENTER WING STATION 105 ON UPPER SURFACE
FOR GROUP 2

TEST RESULTS ADJUSTED FOR GROUP'S USAGE

Theoretical Prediction of Fatigue Endurance vs. Reliability (Ref.: Tables IX, X, XIII, XIV of AFML-TR-69-65)							
Weibull Distribution				Log Normal Distribution			
Weakest Fleet Member		2nd Weakest Fleet Member		Weakest Fleet Member		2nd Weakest Fleet Member	
$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours	$\hat{R}$	Flight Hours	$\hat{R}$	Flight Hours
.368	4,666						
.500	4,248	.50	5,488	.50	5,067	.50	5,867
.507	4,229			.60	4,903		
.750	3,415	.75	4,771	.75	4,657	.75	5,446
.900	2,598	.90	4,015	.90	4,244	.90	5,036
.950	2,218	.95	3,638	.95	3,934	.95	4,860
.980	1,758						
.990	1,476			.99	3,440		
.999	828						

Lowest Observed Times to Crack Initiation (From C-130 Service Experience Data)
Flight Hours
3,295
3,732
3,818
3,888

TABLE XIII

EXPECTED AND OBSERVED VALUES OF FATIGUE ENDURANCE
FOR C-130 B/E CENTER WING STATION 121 ON LOWER SURFACE
FOR GROUP 2

Theoretical Prediction of Fatigue Endurance vs. Reliability (Ref.: Tables IX, X, XIII, XIV of AFML-TR-69-65)							
Weibull Distribution				Log Normal Distribution			
Weakest Fleet Member		2nd Weakest Fleet Member		Weakest Fleet Member		2nd Weakest Fleet Member	
$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours
.368	1,307						
.500	1,192	.50	1,537	.50	1,442	.50	1,671
.507	1,185			.60	1,398		
.750	957	.75	1,338	.75	1,325	.75	1,550
.900	728	.90	1,125	.90	1,210	.90	1,434
.950	622	.95	1,018	.95	1,118	.95	1,386
.980	493						
.990	413			.99	979		
.999	232						

Lowest Observed Times to Crack Initiation (From C-130 Service Experience Data)
Flight Hours
1,347
2,289
2,551
2,680

TABLE XIII (CONTINUED)

EXPECTED AND OBSERVED VALUES OF FATIGUE ENDURANCE FOR C-130 B/E CENTER WING STATION 121 ON LOWER SURFACE FOR GROUP 2

TEST RESULTS ADJUSTED FOR GROUP'S USAGE

Theoretical Prediction of Fatigue Endurance vs. Reliability
(Ref.: Tables IX, X, XIII, XIV of AFML-TR-69-65)

Weibull Distribution				Log Normal Distribution			
Weakest Fleet Member		2nd Weakest Fleet Member		Weakest Fleet Member		2nd Weakest Fleet Member	
$\bar{R}$	Flight Hours	$\bar{\bar{R}}$	Flight Hours	$\bar{R}$	Flight Hours	$\bar{\bar{R}}$	Flight Hours
.368	621						
.500	566	.50	730	.50	685	.50	793
.507	563			.60	664		
.750	455	.75	635	.75	629	.75	736
.900	346	.90	534	.90	575	.90	681
.950	295	.95	484	.95	531	.95	658
.980	234						
.990	196			.99	465		
.999	100						

Lowest Observed Times to Crack Initiation
(From C-130 Service Experience Data)

Flight Hours
1,347
2,289
2,551
2,680

TABLE XIV

[illegible] AND OBSERVED VALUES OF FATIGUE ENDURANCE FOR C-130 B/E CENTER WING STATION 38 ON UPPER SURFACE FOR GROUP 3

Theoretical Prediction of Fatigue Endurance vs. Reliability (Ref.: Tables IX, X, XIII, XIV of AFML-TR-69-65)							
Weibull Distribution				Log Normal Distribution			
Weakest Fleet Member		2nd Weakest Fleet Member		Weakest Fleet Member		2nd Weakest Fleet Member	
$\bar{B}$	Flight Hours	$\bar{B}$	Flight Hours	$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours
.368	2,826						
.500	2,582	.50	3,352	.50	2,748	.50	3,183
.507	2,570			.60	2,668		
.750	2,071	.75	2,905	.75	2,513	.75	2,955
.900	1,577	.90	2,443	.90	2,290	.90	2,739
.950	1,348	.95	2,220	.95	2,125	.95	2,634
.980	1,068						
.990	895			.99	1,848		
.999	503						

Lowest Observed Times to Crack Initiation (From C-130 Service Experience Data)
Flight Hours
4,043
4,234
4,237
4,373

TABLE XIV (CONTINUED)

EXPECTED AND OBSERVED VALUES OF FATIGUE ENDURANCE
FOR C-130 B/E CENTER WING STATION 38 ON UPPER SURFACE
FOR GROUP 3

TEST RESULTS ADJUSTED FOR GROUP'S USAGE

Theoretical Prediction of Fatigue Endurance vs. Reliability (Ref.: Tables IX, X, XIII, XIV of AFML-TR-69-65)							
Weibull Distribution				Log Normal Distribution			
Weakest Fleet Member		2nd Weakest Fleet Member		Weakest Fleet Member		2nd Weakest Fleet Member	
$\bar{\bar{R}}$	Flight Hours	$\bar{\bar{R}}$	Flight Hours	$\bar{\bar{R}}$	Flight Hours	$\bar{\bar{R}}$	Flight Hours
.368	7,454						
.500	6,810	.50	8,840	.50	7,170	.50	8,305
.507	6,776			.60	6,961		
.750	5,461	.75	7,661	.75	6,558	.75	7,710
.900	4,160	.90	6,444	.90	5,975	.90	7,146
.950	3,554	.95	5,856	.95	5,544	.95	6,872
.980	2,817						
.990	2,361			.99	4,823		
.999	1,325						

Lowest Observed Times to Crack Initiation (From C-130 Service Experience Data)
Flight Hours
4,043
4,234
4,237
4,373

TABLE XV

EXPECTED AND OBSERVED VALUES OF FATIGUE ENDURANCE
FOR C-130 B/E CENTER WING STATION 105 ON UPPER SURFACE
FOR GROUP 3

Theoretical Prediction of Fatigue Endurance vs. Reliability (Ref.: Tables IX, X, XIII, XIV of AFML-TR-69-65)							
Weibull Distribution				Log Normal Distribution			
Weakest Fleet Member		2nd Weakest Fleet Member		Weakest Fleet Member		2nd Weakest Fleet Member	
$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours
.368	2,108						
.500	1,922	.50	2,493	.50	2,239	.50	2,596
.507	1,913			.60	2,178		
.750	1,545	.75	2,165	.75	2,047	.75	2,404
.900	1,174	.90	1,822	.90	1,866	.90	2,232
.950	1,004	.95	1,653	.95	1,731	.95	2,152
.980	796						
.990	667			.99	1,505		
.999	375						

Lowest Observed Times to Crack Initiation (From C-130 Service Experience Data)
Flight Hours
3,617
3,793
3,831
3,843

TABLE XV (CONTINUED)

EXPECTED AND OBSERVED VALUES OF FATIGUE ENDURANCE
FOR C-130 B/E CENTER WING STATION 105 ON UPPER SURFACE
FOR GROUP 3

TEST RESULTS ADJUSTED FOR GROUP'S USAGE

Theoretical Prediction of Fatigue Endurance vs. Reliability (Ref.: Tables IX, X, XIII, XIV of AFML-TR-69-65)							
Weibull Distribution				Log Normal Distribution			
Weakest Fleet Member		2nd Weakest Fleet Member		Weakest Fleet Member		2nd Weakest Fleet Member	
$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours
.368	6,649						
.500	6.062	.50	7.864	.50	7,097	.50	8,228
.507	6,033			.60	6,903		
.750	4,875	.75	6,828	.75	6,489	.75	7,621
.900	3,703	.90	5,747	.90	5,914	.90	7,075
.950	3,167	.95	5,216	.95	5,486	.95	6,820
.980	2,510						
.990	2,104			.99	4,771		
.999	1,181						

Lowest Observed Times to Crack Initiation (From C-130 Service Experience Data)
Flight Hours
3,617
3,793
3,831
3,843

TABLE XVI

EXPECTED AND OBSERVED VALUES OF FATIGUE ENDURANCE
FOR C-130 B/E CENTER WING STATION 121 ON LOWER SURFACE
FOR GROUP 3

Theoretical Prediction of Fatigue Endurance vs. Reliability (Ref.: Tables IX, X, XIII, XIV of AFML-TR-69-65)							
Weibull Distribution				Log Normal Distribution			
Weakest Fleet Member		2nd Weakest Fleet Member		Weakest Fleet Member		2nd Weakest Fleet Member	
$\bar{\bar{R}}$	Flight Hours	$\bar{\bar{R}}$	Flight Hours	$\bar{\bar{R}}$	Flight Hours	$\bar{\bar{R}}$	Flight Hours
.368	1,395						
.500	1,271	.50	1,651	.50	1,488	.50	1,728
.507	1,265			.60	1,446		
.750	1,020	.75	1,431	.75	1,361	.75	1,599
.900	776	.90	1,203	.90	1,240	.90	1,480
.950	663	.95	1,094	.95	1,151	.95	1,427
.980	526						
.990	441			.99	1,000		
.999	248						

Lowest Observed Times to Crack Initiation (From C-130 Service Experience Data)
Flight Hours
2,327
2,451
2,574
2,690

TABLE XVI (CONTINUED)

EXPECTED AND OBSERVED VALUES OF FATIGUE ENDURANCE
FOR C-130 B/E CENTER WING STATION 121 ON LOWER SURFACE
FOR GROUP 3

TEST RESULTS ADJUSTED FOR GROUP'S USAGE

Theoretical Prediction of Fatigue Endurance vs. Reliability (Ref.: Tables IX, X, XIII, XIV of AFML-TR-69-65)							
Weibull Distribution				Log Normal Distribution			
Weakest Fleet Member		2nd Weakest Fleet Member		Weakest Fleet Member		2nd Weakest Fleet Member	
$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours
.368	1,180						
.500	1,070	.50	1,390	.50	1,250	.50	1,460
.507	1,070			.60	1,220		
.750	860	.75	1,210	.75	1,150	.75	1,350
.900	650	.90	1,010	.90	1,040	.90	1,250
.950	560	.95	920	.95	970	.95	1,200
.980	440						
.990	370			.99	840		
.999	210						

Lowest Observed Times to Crack Initiation (From C-130 Service Experience Data)
Flight Hours
2,327
2,451
2,574
2,690

TABLE XVII

EXPECTED AND OBSERVED VALUES OF FATIGUE ENDURANCE
FOR C-130 B/E CENTER WING STATION 38 ON UPPER SURFACE
FOR GROUP 4

Theoretical Prediction of Fatigue Endurance vs. Reliability (Ref.: Tables IX, X, XIII, XIV of AFML-TR-69-65)							
Weibull Distribution				Log Normal Distribution			
Weakest Fleet Member		2nd Weakest Fleet Member		Weakest Fleet Member		2nd Weakest Fleet Member	
$\bar{\bar{R}}$	Flight Hours	$\bar{\bar{R}}$	Flight Hours	$\bar{\bar{R}}$	Flight Hours	$\bar{\bar{R}}$	Flight Hours
.368	3,268						
.500	2,979	.50	3,722	.50	2,976	.50	3,351
.507	2,963			.60	2,853		
.750	2,393	.75	3,238	.75	2,685	.75	3,088
.900	1,819	.90	2,709	.90	2,403	.90	2,863
.950	1,554	.95	2,478	.95	2,265	.95	2,766
.980	1,232						
.990	1,033			.99	1,931		
.999	580						

Lowest Observed Times to Crack Initiation (From C-130 Service Experience Data)
Flight Hours
3,860
3,909
4,047
4,196

TABLE XVII (CONTINUED)

EXPECTED AND OBSERVED VALUES OF FATIGUE ENDURANCE
FOR C-130 B/E CENTER WING STATION 38 ON UPPER SURFACE
FOR GROUP 4

TEST RESULTS ADJUSTED FOR GROUP'S USAGE

Theoretical Prediction of Fatigue Endurance vs. Reliability (Ref.: Tables IX, X, XIII, XIV of AFML-TR-69-65)							
Weibull Distribution				Log Normal Distribution			
Weakest Fleet Member		2nd Weakest Fleet Member		Weakest Fleet Member		2nd Weakest Fleet Member	
$\bar{\bar{R}}$	Flight Hours	$\bar{\bar{R}}$	Flight Hours	$\bar{R}$	Flight Hours	$\bar{\bar{R}}$	Flight Hours
.368	8,384						
.500	7,644	.50	9,548	.50	7,682	.50	8,650
.507	7,601			.60	7,363		
.750	6,140	.75	8,307	.75	6,932	.75	7,970
.900	4,666	.90	6,951	.90	6,204	.90	7,389
.950	3,987	.95	6,358	.95	5,846	.95	7,141
.980	3,160						
.990	2,651			.99	4,984		
.999	1,487						

Lowest Observed Times to Crack Initiation (From C-130 Service Experience Data)
Flight Hours
3,860
3,909
4,047
4,196

TABLE XVIII

EXPECTED AND OBSERVED VALUES OF FATIGUE ENDURANCE
FOR C-130 B/E CENTER WING STATION 105 ON UPPER SURFACE
FOR GROUP 4

Theoretical Prediction of Fatigue Endurance vs. Reliability (Ref.: Tables IX, X, XIII, XIV of AFML-TR-69-65)							
Weibull Distribution				Log Normal Distribution			
Weakest Fleet Member		2nd Weakest Fleet Member		Weakest Fleet Member		2nd Weakest Fleet Member	
$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours
.368	2,433						
.500	2,218	.50	2,777	.50	2,429	.50	2,724
.507	2,206			.60	2,319		
.750	1,781	.75	2,411	.75	2,184	.75	2,523
.900	1,356	.90	2,023	.90	1,958	.90	2,334
.950	1,159	.95	1,847	.95	1,847	.95	2,253
.980	918						
.990	770			.99	1,571		
.999	432						

Lowest Observed Times to Crack Initiation (From C-130 Service Experience Data)
Flight Hours
4,100
4,241
4,246
4,309

TABLE XVIII (CONTINUED)

EXPECTED AND OBSERVED VALUES OF FATIGUE ENDURANCE
FOR C-130 B/E CENTER WING STATION 105 ON UPPER SURFACE
FOR GROUP 4

TEST RESULTS ADJUSTED FOR GROUP'S USAGE

Theoretical Prediction of Fatigue Endurance vs. Reliability (Ref.: Tables IX, X, XIII, XIV of AFML-TR-69-65)							
Weibull Distribution				Log Normal Distribution			
Weakest Fleet Member		2nd Weakest Fleet Member		Weakest Fleet Member		2nd Weakest Fleet Member	
$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours
.368	7,674						
.500	6,998	.50	8,759	.50	7,695	.50	8,631
.507	6,959			.60	7,346		
.750	5,619	.75	7,605	.75	6,921	.75	7,993
.900	4,276	.90	6,382	.90	6,202	.90	7,394
.950	3,655	.95	5,826	.95	5,851	.95	7, 38
.980	2,896						
.990	2,428			.99	4,978		
.999	1,363						

Lowest Observed Times to Crack Initiation (From C-130 Service Experience Data)
Flight Hours
4,100
4,241
4,246
4,309

TABLE XIX

EXPECTED AND OBSERVED VALUES OF FATIGUE ENDURANCE
FOR C-130 B/E CENTER WING STATION 121 ON LOWER SURFACE
FOR GROUP 4

Theoretical Prediction of Fatigue Endurance vs. Reliability (Ref.: Tables IX, X, XIII, XIV of AFML-TR-69-65)							
Weibull Distribution				Log Normal Distribution			
Weakest Fleet Member		2nd Weakest Fleet Member		Weakest Fleet Member		2nd Weakest Fleet Member	
$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours
.368	1,608						
.500	1,468	.50	1,836	.50	1,613	.50	1,812
.507	1,457			.60	1,541		
.750	1,177	.75	1,594	.75	1,453	.75	1,676
.900	896	.90	1,335	.90	1,301	.90	1,550
.950	765	.95	1,221	.95	1,226	.95	1,496
.980	607						
.990	509			.99	1,045		
.999	286						

Lowest Observed Times to Crack Initiation (From C-130 Service Experience Data)
Flight Hours
3,551
3,663
3,682
3,745

TABLE XIX (CONTINUED)

EXPECTED AND OBSERVED VALUES OF FATIGUE ENDURANCE
FOR C-130 B/E CENTER WING STATION 121 ON LOWER SURFACE
FOR GROUP 4

TEST RESULTS ADJUSTED FOR GROUP'S USAGE

Theoretical Prediction of Fatigue Endurance vs. Reliability (Ref.: Tables IX, X, XIII, XIV of AFML-TR-69-65)							
Weibull Distribution				Log Normal Distribution			
Weakest Fleet Member		2nd Weakest Fleet Member		Weakest Fleet Member		2nd Weakest Fleet Member	
$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours	$\bar{R}$	Flight Hours
.368	2,363						
.500	2,158	.50	2,697	.50	2,370	.50	2,662
.507	2,141			.60	2,265		
.750	1,730	.75	2,343	.75	2,135	.75	2,462
.900	1,316	.90	1,962	.90	1,911	.90	2,278
.950	1,125	.95	1,794	.95	1,802	.95	2,198
.980	891						
.990	747			.99	1,536		
.999	420						

Lowest Observed Times to Crack Initiation (From C-130 Service Experience Data)
Flight Hours
3,551
3,663
3,682
3,745

TABLE XX

SUMMARY OF STUDY RESULTS

Group	C-130 Center Wing Station	Test Endurance(s)	Equivalent Test Endurance Based On Scatter Factor = 4	Total Number Airplanes In Group	AFML-Freudenthal-Boeing Methods Median Time to Crack Initiation				Observed 1st Crack Initiation Time In Group	Observed 2nd Crack Initiation Time In Group
					Weakest Member of Group		2nd Weakest Member of Group			
					Table XIII Log Normal	Table IX Weibull	Table XIV Log Normal	Table X Weibull		
Units	Inches	Hours	Hours		Hours	Hours	Hours	Hours	Hours	Hours
Whole Fleet	38	5,400	1,350	432	2,340	1,760	2,680	2,310	2,778	2,884
	38	7,800	1,950	432	2,340	1,760	2,680	2,310	2,778	2,884
	38	13,300	3,325	432	2,340	1,760	2,680	2,310	2,778	2,884
	105	5,520	1,380	432	1,910	1,310	2,180	1,720	3,295	3,617
	105	9,300	2,325	432	1,910	1,310	2,180	1,720	3,295	3,617
	121	5,640	1,410	432	1,280	960	1,470	1,150	1,347	2,289
Group 1	38	5,400	1,350	102	2,703	2,508	3,147	3,268	6,230	6,595
	38	7,800	1,950	102	2,703	2,508	3,147	3,268	6,230	6,595
	38	13,300	3,325	102	2,703	2,508	3,147	3,268	6,230	6,595
	105	5,520	1,380	102	2,205	1,868	2,568	2,433	6,328	6,335
	105	9,300	2,325	102	2,205	1,868	2,568	2,433	6,328	6,335
	121	5,640	1,410	102	1,465	1,234	1,706	1,608	6,024	6,094
Group 2	38	5,400	1,350	121	2,659	2,421	3,088	3,122	2,778	2,884
	38	7,800	1,950	121	2,659	2,421	3,088	3,122	2,778	2,884
	38	13,300	3,325	121	2,659	2,421	3,088	3,122	2,778	2,884
	105	5,520	1,380	121	2,171	1,801	2,514	2,327	3,295	3,732
	105	9,300	2,325	121	2,171	1,801	2,514	2,327	3,295	3,732
	121	5,640	1,410	121	1,442	1,192	1,671	1,537	1,347	2,289

TABLE XX (CONTINUED)

SUMMARY OF STUDY RESULTS

Group	C-130 Center Wing Station	Test Endurance(s)	Equivalent Test Endurance Based On Scutter Factor = 4	Total Number Airplanes In Group	AFML - Freudenthal - Boeing Methods Median Time to Crack Initiation				Observed 1st Crack Initiation Time In Group	Observed 2nd Crack Initiation Time In Group
					Weakest Member of Group		2nd Weakest Member of Group			
					Table XIII Log Normal	Table IX Weibull	Table XIV Log Normal	Table X Weibull		
Units	Inches	Hours	Hours		Hours	Hours	Hours	Hours	Hours	Hours
Group 3	38	5,400	1,350	92	2,748	2,582	3,183	3,352	4,043	4,234
	38	7,800	1,950	92	2,748	2,582	3,183	3,352	4,043	4,234
	38	13,300	3,325	92	2,748	2,582	3,183	3,352	4,043	4,234
	105	5,520	1,380	92	2,239	1,922	2,596	2,493	3,617	3,793
	105	9,300	2,325	92	2,239	1,922	2,596	2,493	3,617	3,793
	121	5,640	1,410	92	1,488	1,271	1,728	1,651	2,327	2,451
Group 4	38	5,400	1,350	51	2,976	2,979	3,351	3,722	3,860	3,909
	38	7,800	1,950	51	2,976	2,979	3,351	3,722	3,860	3,909
	38	13,300	3,325	51	2,976	2,979	3,351	3,722	3,860	3,909
	105	5,520	1,380	51	2,429	2,218	2,724	2,777	4,100	4,241
	105	9,300	2,325	51	2,429	2,218	2,724	2,777	4,100	4,241
	121	5,640	1,410	51	1,613	1,468	1,812	1,836	3,551	3,663

TABLE XXI
PERCENT ERRORS IN FATIGUE ENDURANCE
PREDICTION FOR C-130 WHOLE FLEET

C-130 Center Wing Station	Weakest Fleet Member			2nd Weakest Fleet Member		
	Predicted		Observed Hours	Predicted		Observed Hours
	$\bar{R}=.5$	$\bar{R}=.95$		$\bar{R}=.5$	$\bar{R}=.95$	
Weibull Distribution:						
38	-23	-60	2272	-17	-45	2778
105	180	45	468	9	39	1887
121	-11	-54	990	-15	-44	1347
Log Normal Distribution:						
38	3	-18	2272	- 4	-19	2778
105	308	225	468	16	-02	1887
121	29	3	990	9	- 9	1347

TABLE XXII
PERCENT ERRORS IN FATIGUE ENDURANCE
PREDICTION FOR C-130 WHOLE FLEET
EXCEPT "SKY HOOK" AIRCRAFT

C-130 Center Wing Station	Weakest Fleet Member			2nd Weakest Fleet Member		
	Predicted		Observed Hours	Predicted		Observed Hours
	$\bar{R}$=.5	$\bar{R}$=.95		$\bar{R}$=.5	$\bar{R}$=.95	
Weibull Distribution						
38	-37	-67	2778	-20	-47	2884
105	-60	-79	3295	-52	-68	3617
121	-35	-66	1347	-50	-67	2289
Log Normal Distribution						
38	-16	-33	2778	- 7	-22	2884
105	-42	-54	3295	-40	-49	3617
121	- 5	-24	1347	-36	-46	2289

TABLE XXIII
PERCENT ERRORS IN FATIGUE ENDURANCE
PREDICTION FOR C-130 USAGE GROUP ONE

C-130 Center Wing Station	Weakest Fleet Member			2nd Weakest Fleet Member		
	Predicted		Observed Hours	Predicted		Observed Hours
	$\bar{R}=.5$	$\bar{R}=.95$		$\bar{R}=.5$	$\bar{R}=.95$	
Weibull Distribution:						
38	-60	-79	6230	-50	-67	6595
105	-71	-85	6328	-62	-75	6335
121	-79	-89	6024	-74	-82	6094
Log Normal Distribution:						
38	-57	-67	6230	-52	-61	6595
105	-65	-73	6328	-59	-66	6335
121	-76	-81	6024	-72	-77	6094

TABLE XXIV
PERCENT ERRORS IN FATIGUE ENDURANCE
PREDICTION FOR C-130 USAGE GROUP TWO

C-130 Center Wing Station	Weakest Fleet Member			2nd Weakest Fleet Member		
	Predicted		Observed Hours	Predicted		Observed Hours
	$\bar{R}$=.5	$\bar{R}$=.95		$\bar{R}$=.5	$\bar{R}$=.95	
Weibull Distribution:						
38	-13	-55	2778	8	-28	2884
105	-45	-71	3295	-38	-59	3732
121	-11	-54	1347	-33	-56	2289
Log Normal Distribution:						
38	- 4	-26	2778	7	-11	2884
105	-34	-49	3295	-33	-44	3732
121	7	-17	1347	-27	-40	2289

TABLE XXV
PERCENT ERRORS IN FATIGUE ENDURANCE PREDICTION FOR C-130 USAGE GROUP THREE

C-130 Center Wing Station	Weakest Fleet Member			2nd Weakest Fleet Member		
	Predicted		Observed Hours	Predicted		Observed Hours
	$\bar{R}=.5$	$\bar{R}=.95$		$\bar{R}=.5$	$\bar{R}=.95$	
Weibull Distribution:						
38	-36	-67	4043	-21	-47	4234
105	-47	-72	3617	-34	-56	3793
121	-45	-72	2327	-33	-55	2451
Log **Normal** Distribution:						
38	-32	-47	4043	-25	-38	4234
105	-38	-52	3617	-32	-43	3793
121	-36	-50	2327	-30	-42	2451

TABLE XXVI
PERCENT ERRORS IN FATIGUE ENDURANCE
PREDICTION FOR C-130 USAGE GROUP FOUR

C-130 Center Wing Station	Weakest Fleet Member			2nd Weakest Fleet Member		
	Predicted		Observed Hours	Predicted		Observed Hours
	$\bar{R}=.5$	$\bar{R}=.95$		$\bar{R}=.5$	$\bar{R}=.95$	
Weibull Distribution:						
38	-23	-60	3860	- 5	-37	3909
105	-46	-72	4100	-35	-57	4241
121	-59	-79	3551	-50	-67	3663
Log Normal Distribution:						
38	-23	-41	3860	-14	-29	3909
105	-41	-55	4100	-36	-47	4241
121	-55	-66	3551	-50	-59	3663

TABLE XXVII
PERCENT ERRORS IN ADJUSTED FATIGUE ENDURANCE PREDICTION FOR C-130 USAGE GROUP ONE

C-130 Center Wing Station	Weakest Fleet Member			2nd Weakest Fleet Member		
	Predicted		Observed Hours	Predicted		Observed Hours
	$\bar{R}$=.5	$\bar{R}$=.95		$\bar{R}$=.5	$\bar{R}$=.95	
Weibull Distribution:						
38	41	-27	6230	73	15	6595
105	28	-33	6328	67	11	6335
121	-57	-78	6024	-45	-63	6094
Log Normal Distribution:						
38	54	19	6230	69	40	6595
105	52	17	6328	77	46	6335
121	-49	-61	6024	-41	-51	6094

TABLE XXVIII
PERCENT ERRORS IN ADJUSTED FATIGUE ENDURANCE
PREDICTION FOR C-130 USAGE GROUP TWO

C-130 Center Wing Station	Weakest Fleet Member			2nd Weakest Fleet Member		
	Predicted		Observed Hours	Predicted		Observed Hours
	$\bar{R}=.5$	$\bar{R}=.95$		$\bar{R}=.5$	$\bar{R}=.95$	
Weibull Distribution:						
38	73	-10	2778	115	42	2884
105	29	-33	3295	47	- 3	3732
121	-58	-78	1347	-68	-79	2289
Log Normal Distribution:						
38	87	46	2778	110	73	2884
105	54	19	3295	57	30	3732
121	-49	-61	1347	-65	-71	2289

TABLE XXIX
PERCENT ERRORS IN ADJUSTED FATIGUE ENDURANCE
PREDICTION FOR C-130 USAGE GROUP THREE

C-130 Center Wing Station	Weakest Fleet Member			2nd Weakest Fleet Member		
	Predicted		Observed Hours	Predicted		Observed Hours
	$\bar{R}=.5$	$\bar{R}=.95$		$\bar{R}=.5$	$\bar{R}=.95$	
Weibull Distribution:						
38	68	-12	4043	109	39	4234
105	68	-12	3617	108	37	3793
121	-54	-76	2327	-43	-62	2451
Log Normal Distribution:						
38	78	37	4043	96	63	4234
105	96	51	3617	117	80	3793
121	-46	-58	2327	-40	-51	2451

TABLE XXX
PERCENT ERRORS IN ADJUSTED FATIGUE ENDURANCE PREDICTION FOR C-130 USAGE GROUP FOUR

C-130 Center Wing Station	Weakest Fleet Member			2nd Weakest Fleet Member		
	Predicted		Observed Hours	Predicted		Observed Hours
	$\bar{R}=.5$	$\bar{R}=.95$		$\bar{R}=.5$	$\bar{R}=.95$	
Weibull Distribution						
38	98	3	3860	144	63	3909
105	70	-11	4100	107	38	4241
121	-39	-68	3551	-26	-51	3663
Log Normal Distribution						
38	99	51	3860	122	82	3909
105	88	43	4100	104	68	4241
121	-33	-49	3551	-27	-40	3663

TABLE XXXI

SUMMARY OF RANGE OF PERCENT ERRORS

IN C-130 FATIGUE ENDURANCE PREDICTIONS

Type of Prediction	Percent Error Range	
	$\bar{R}$ = .5	$\bar{R}$ = .95
Weibull - Weakest Member		
C-130 Whole Fleet	-23 to 180	-60 to 45
C-130 Usage Group Unadjusted	-79 to -11	-89 to -54
C-130 Usage Group Adjusted	-58 to 98	-78 to 3
Log Normal - Weakest Member		
C-130 Whole Fleet	3 to 308	-18 to 225
C-130 Usage Group Unadjusted	-76 to 7	-81 to -17
C-130 Usage Group Adjusted	-49 to 99	-61 to 51
Weibull 2nd - Weakest Member		
C-130 Whole Fleet	-17 to 9	-45 to 39
C-130 Usage Group Unadjusted	-74 to 8	-82 to -28
C-130 Usage Group Adjusted	-68 to 144	-79 to 63
Log Normal - 2nd Weakest Member		
C-130 Whole Fleet	-4 to 16	-19 to -02
C-130 Usage Group Unadjusted	-72 to 7	-77 to -11
C-130 Usage Group Adjusted	-65 to 122	-71 to 82

TABLE XXXII

PROBABILITY OF LARGER MINIMUM C-130 TEST VALUE

ON THE BASIS OF EMPIRICAL DISTRIBUTION.

C-130 Center Wing Station	$P(t > T_{T_{min}})$								
	Whole Fleet	Unadjusted Group				Adjusted Group			
		1	2	3	4	1	2	3	4
38	.48	1.00	.10	.003	.38	.00	.00	.00	.00
105	.67	1.00	.38	.20	.66	.00	.00	.00	.00
121	.36	.98	.01	.00	.19	.00	.97	.05	.00

Note: In cases where the empirical distribution is not known completely enough, the best fit double parameter Weibull is used.

TABLE XXXIII

PROBABILITY OF SMALLER MAXIMUM C-130 TEST VALUE

ON THE BASIS OF EMPIRICAL DISTRIBUTION

C-130 Center Wing Station	$P(t \leq T_{T_{max}})$								
	Whole Fleet	Unadjusted Group				Adjusted Group			
		1	2	3	4	1	2	3	4
38	.91	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
105	.15	.06	1.00	1.00	1.00	1.00	1.00	1.00	1.00
121	.64	.02	.99	1.00	.81	1.00	.03	.95	1.00

Note: In cases where the empirical distribution is not known completely enough, the best fit double parameter Weibull distribution is used.

TABLE XXXIV

CENSORED SUMMARY OF RANGE OF PERCENT ERRORS
IN C-130 FATIGUE ENDURANCE PREDICTIONS

Type of Prediction	Percent Error Range	
	$\bar{R} = .5$	$\bar{R} = .95$
Weibull - Weakest Member		
C-130 Whole Fleet	-60 to -35	-79 to -66
C-130 Usage Group Unadjusted	-59	-79
Log Normal - Weakest Member		
C-130 Whole Fleet	-42 to -5	-54 to -24
C-130 Usage Group Unadjusted	-55	-66
Weibull - 2nd Weakest Member		
C-130 Whole Fleet	-52 to 20	-68 to -47
C-130 Usage Group Unadjusted	-50	-67
Log Normal - 2nd Weakest Member		
C-130 Whole Fleet	-40 to -7	-49 to -22
C-130 Usage Group Unadjusted	-50	-59

TABLE XXXV

VALUES OF C-130 SCALE PARAMETERS
Weibull Distribution

Sets	Wing Station		
	38 U.S.	105 U.S.	121 L.S.
Whole Fleet - Empirical			5,550
Best Fit Distribution			
Complete Data			
With Assumed α	8,394	8,839	5,433
With Empirical α	8,751	11,633	5,677
Truncated Data			
With Assumed α	8,064	8,470	5,102
With Empirical α	6,204	12,963	5,057
Test Distribution	10,455	8,052	5,580
Group 1 - Empirical			8,000
Best Fit Distribution			
Complete Data			
With Assumed α	12,211	13,559	9,204
With Empirical α	9,380	10,251	7,985
Truncated Data			
With Assumed α	12,697	13,682	10,656
With Empirical α	8,894	9,507	7,705
Test Distribution	10,455	8,052	5,580
Adjusted Test	36,505	35,000	11,700
Group 2 - Empirical	7,200		4,400
Best Fit Distribution			
Complete Data			
With Assumed α	6,339	7,293	4,779
With Empirical α	5,494	6,362	4,490
Truncated Data			
With Assumed α	6,444	7,292	5,321
With Empirical α	5,179	5,686	4,936
Test Distribution	10,455	8,052	5,580
Adjusted Test	20,747	18,993	26,500
Group 3 - Empirical			3,500
Best Fit Distribution			
Complete Data			
With Assumed α	9,748	8,318	3,917
With Empirical α	5,175	5,631	3,493
Truncated Data			
With Assumed α	9,748	8,373	4,417
With Empirical α	5,175	5,010	3,407
Test Distribution	10,455	8,052	5,580
Adjusted Test	27,583	25,404	4,700
Group 4 - Empirical			4,700
Best Fit Distribution			
Complete Data			
With Assumed α	7,460	8,167	5,371
With Empirical α	5,925	6,891	4,845
Truncated Data			
With Assumed α	7,493	8,271	5,994
With Empirical α	5,619	6,453	4,210
Test Distribution	10,455	8,052	5,580
Adjusted Test	26,833	25,404	8,200

TABLE XXXV (CONTINUED)

VALUES OF C-130 SCALE PARAMETERS
Log-Normal Distribution

Sets	Wing Station		
	38 U.S.	105 U.S.	121 L.S.
Whole Fleet - Empirical	8,500		4,500
Best Fit Distribution			
Complete Data			
With Assumed σ	7,190	7,398	4,715
With Empirical σ	8,394	12,246	4,796
Truncated Data			
With Assumed σ	6,669	6,845	4,463
With Empirical σ	6,626	17,188	5,013
Test Distribution	8,244	7,165	5,580
Group 1 - Empirical			7,700
Best Fit Distribution			
Complete Data			
With Assumed σ	10,517	11,418	7,886
With Empirical σ	9,260	10,350	7,632
Truncated Data			
With Assumed σ	10,757	11,428	9,196
With Empirical σ	8,954	9,744	7,645
Test Distribution	8,244	7,165	5,580
Adjusted Test	29,178	31,203	11,700
Group 2 - Empirical	5,000	7,200	4,200
Best Fit Distribution			
Complete Data			
With Assumed σ	5,559	6,342	4,117
With Empirical σ	5,296	6,166	4,110
Truncated Data			
With Assumed σ	5,616	6,297	4,674
With Empirical σ	5,130	5,658	4,834
Test Distribution	8,244	7,165	5,580
Adjusted Test	16,135	16,715	26,500
Group 3 - Empirical			3,300
Best Fit Distribution			
Complete Data			
With Assumed σ	7,544	6,709	3,374
With Empirical σ	5,403	5,904	3,316
Truncated Data			
With Assumed σ	7,544	6,693	3,852
With Empirical σ	5,403	5,219	3,357
Test Distribution	8,244	7,165	5,580
Adjusted Test	21,511	22,709	4,700
Group 4 - Empirical			4,200
Best Fit Distribution			
Complete Data			
With Assumed σ	6,378	6,956	4,657
With Empirical σ	5,929	6,919	4,502
Truncated Data			
With Assumed σ	6,369	6,934	5,183
With Empirical σ	5,659	6,596	4,181
Test Distribution	8,244	7,165	5,580
Adjusted Test	21,284	22,709	8,200

TABLE XXXVI
PERCENT DIFFERENCES BETWEEN CALCULATED AND EMPIRICAL C-130 VALUES OF SCALE PARAMETERS
Weibull Distribution

(Ref. Table XXXV)

Set	Empir. Values	Best Fit Distributions				Test Dist.	Adj. Test Dist.
		Complete Data		Truncated Data			
		Assum. α	Empir. α	Assum. α	Empir. α		
Whole Fleet W. S. 38 W. S. 105 W. S. 121	5,550	- 2.1	2.3	- 8.9	- 8.9	.5	
Group 1 W. S. 38 W. S. 105 W. S. 121	8,000	15.0	- .2	33.2	- 4.7	-30.3	46.2
Group 2 W. S. 38	7,200	-12.0	-23.7	-10.5	-28.1	45.2	188.2
W. S. 105 W. S. 121	4,400	8.6	2.0	20.9	12.2	26.8	502.3
Group 3 W. S. 38 W. S. 105 W. S. 121	3,500	11.9	- .2	26.2	- 2.7	59.4	34.3
Group 4 W. S. 38 W. S. 105 W. S. 121	4,700	14.3	3.1	27.5	-10.4	18.7	74.5

TABLE XXXVI (CONTINUED)
PERCENT DIFFERENCES BETWEEN CALCULATED AND EMPIRICAL
C-130 VALUES OF SCALE PARAMETERS
Log Normal Distribution

(Ref. Table XXXV)

Set	Empir. Values	Best Fit Distributions				Test Dist.	Adj. Test Dist.
		Complete Data		Truncated Data			
		Assum. α	Empir. α	Assum. α	Empir. α		
Whole Fleet							
W. S. 38	8,500	-15.4	- 1.2	-21.5	-22.0	- 3.0	
W. S. 105							
W. S. 121	4,500	4.8	6.6	- .8	11.4	24.0	
Group 1							
W. S. 38							
W. S. 105							
W. S. 121	7,700	2.4	- .9	19.4	- .7	-27.5	51.9
Group 2							
W. S. 38	5,000	11.2	5.9	12.3	2.6	64.9	222.7
W. S. 105	7,200	-11.9	-14.4	-12.5	-21.4	- .5	132.2
W. S. 121	4,200	- 2.0	- 2.1	11.3	15.1	32.9	531.0
Group 3							
W. S. 38							
W. S. 105							
W. S. 121	3,300	2.2	.5	16.7	1.7	69.1	42.4
Group 4							
W. S. 38							
W. S. 105							
W. S. 121	4,200	10.9	7.2	23.4	.5	32.9	95.2

TABLE XXXVII

EXACT EXPECTED VALUES OF C-130 SCATTER FACTORS

Scatter Factor Versus Reliability Based on Weibull Distribution For Weakest

For Several Values of Shape Parameter

(Ref. Appendix)

R	α	Whole Fleet 439 Aircraft, Test Sample Size			Group 1 102 Aircraft, Test Sample Size			Group 2 121 Aircraft, Test Sample Size			Group 3 92 Aircraft, Test Sample Size			Group 4 51 Aircraft, Test Sample Size		
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
.500	4.0	4.56	4.78	4.85	3.18	3.33	3.38	3.32	3.48	3.53	3.10	3.25	3.30	2.67	2.80	2.84
	4.139	4.33	4.53	4.60	3.06	3.20	3.25	3.19	3.33	3.38	2.98	3.12	3.17	2.59	2.71	2.75
	4.456	3.90	4.07	4.13	2.83	2.95	2.99	2.93	3.06	3.10	2.76	2.88	2.92	2.42	2.52	2.56
.750	4.0	6.00	6.11	6.15	4.18	4.26	4.29	4.36	4.45	4.47	4.08	4.15	4.18	3.52	3.58	3.61
	4.139	5.65	5.75	5.79	3.99	4.06	4.08	4.15	4.23	4.25	3.89	3.96	3.98	3.37	3.43	3.45
	4.456	4.99	5.08	5.11	3.61	3.67	3.69	3.75	3.82	3.84	3.53	3.59	3.61	3.09	3.14	3.16
.950	4.0	9.52	9.55	9.56	6.63	6.66	6.66	6.92	6.95	6.95	6.47	6.49	6.49	5.58	5.60	5.60
	4.139	8.82	8.85	8.86	6.23	6.25	6.25	6.49	6.51	6.52	6.07	6.09	6.10	5.27	5.28	5.29
	4.456	7.56	7.58	7.59	5.47	5.48	5.49	5.68	5.70	5.70	5.34	5.36	5.36	4.68	4.69	4.70

TABLE XXXVIII

EXACT EXPECTED VALUES OF C-130 FATIGUE ENDURANCE

Theoretical Prediction of Fatigue Endurance Versus Reliability Based on Weibull Distribution For Weakest Fleet Member For Several Values of Shape Parameters **(Ref. Appendix)**

$\bar{R}$	α	Whole Fleet 439 Aircraft, Wing Station 38	Whole Fleet 439 Aircraft, Wing Station 105	Whole Fleet 439 Aircraft, Wing Station 121	Group 1 102 Aircraft, Wing Station 38	Group 1 102 Aircraft, Wing Station 105	Group 1 102 Aircraft, Wing Station 121	Group 2 121 Aircraft, Wing Station 38	Group 2 121 Aircraft, Wing Station 105	Group 2 121 Aircraft, Wing Station 121	Group 3 92 Aircraft, Wing Station 38	Group 3 92 Aircraft, Wing Station 105	Group 3 92 Aircraft, Wing Station 121	Group 4 51 Aircraft, Wing Station 38	Group 4 51 Aircraft, Wing Station 105	Group 4 51 Aircraft, Wing Station 121
.50	4.0	2,155	1,685	1,237	3,091	2,417	1,775	2,962	2,316	1,701	3,172	2,481	1,821	3,676	2,875	2,111
	4.139	2,285	1,781	1,302	3,239	2,525	1,845	3,108	2,422	1,770	3,320	2,588	1,892	3,829	2,985	2,181
	4.456	2,578	1,996	1,445	3,565	2,760	1,998	3,430	2,656	1,922	3,648	2,825	2,044	4,164	3,225	2,334
.75	4.0	1,700	1,317	940	2,439	1,890	1,348	2,337	1,811	1,292	2,502	1,939	1,384	2,900	2,247	1,604
	4.139	1,817	1,404	998	2,575	1,990	1,415	2,471	1,909	1,358	2,640	2,040	1,451	3,045	2,353	1,673
	4.456	2,084	1,600	1,129	2,881	2,213	1,561	2,773	2,129	1,502	2,948	2,265	1,598	3,366	2,585	1,824
.95	4.0	1,094	843	593	1,569	1,210	850	1,503	1,159	815	1,610	1,241	872	1,866	1,439	1,011
	4.139	1,186	912	639	1,682	1,293	906	1,614	1,241	869	1,724	1,326	929	1,988	1,529	1,071
	4.456	1,403	1,072	746	1,939	1,483	1,032	1,866	1,427	993	1,985	1,517	1,056	2,265	1,732	1,205

TABLE XXXIX

PERCENT DIFFERENCE BETWEEN CONSERVATIVE AND EXACT EXPECTED VALUES OF C-130 FATIGUE ENDURANCE

Based on Weibull Distribution For Weakest Fleet Member

(Ref. Tables V thru XIX and Table XXXVIII)

α	$\bar{R}$	Whole Fleet 439 Aircraft			Group 1 102 Aircraft			Group 2 121 Aircraft			Group 3 92 Aircraft			Group 4 51 Aircraft		
		Wing Station			Wing Station			Wing Station			Wing Station			Wing Station		
		38	105	121	38	105	121	38	105	121	38	105	121	38	105	121
4.0	.5	-18.3	-22.3	-28.9	-19.0	-22.7	-30.5	-18.3	-22.2	-29.9	-18.6	-22.5	-30.2	-19.0	-22.8	-30.5
4.0	.75	-17.1	-20.3	-25.5	-17.6	-20.7	-26.5	-16.8	-20.0	-25.9	-17.2	-20.3	-26.3	-17.5	-20.7	-26.6
4.0	.95	-16.2	-19.3	-22.4	-16.6	-19.4	-24.2	-16.0	-18.9	-23.7	-16.3	-19.1	-24.0	-16.7	-19.5	-24.3
4,139	.5	-23.0	-26.4	-32.4	-22.6	-26.0	-33.1	-22.1	-25.6	-32.7	-22.2	-25.7	-32.8	-22.2	-25.7	-32.7
4,139	.75	-22.4	-25.2	-29.9	-21.9	-24.7	-30.0	-21.3	-24.1	-29.5	-21.6	-24.3	-29.7	-21.4	-24.3	-29.6
4,139	.95	-22.7	-25.5	-28.0	-22.2	-24.6	-28.9	-21.7	-24.2	-28.4	-21.8	-24.3	-28.6	-21.8	-24.2	-28.6

TABLE XXXX

C-130 EMPIRICAL SHAPE PARAMETERS

Weibull Distribution Proposed α = 4.0

Values of α From C-130 Complete Data Best Fits			
Set	C-130 Center Wing Stations		
	38 U.S.	105 U.S.	121 L.S.
Group I	9.13	7.7	11.7
Group II	6.5	5.8	6.3
Group III	16.9	8.7	10.1
Group IV	7.0	5.7	7.0
Whole Fleet	3.63	2.62	3.2

Values of α From C-130 Truncated Data Best Fits			
Set	C-130 Center Wing Station		
	38 U.S.	105 U.S.	121 L.S.
Group I	11.4	9.9	14.9
Group II	8.3	8.4	4.9
Group III	16.9	12.9	11.9
Group IV	8.2	6.7	20.7
Whole Fleet	6.8	2.4	4.1

TABLE XXXX (CONTINUED)

C-130 EMPIRICAL SHAPE PARAMETERS

Log Normal Distributions Proposed $\sigma = 0.322$

Values of σ From C-130 Complete Data Best Fits

Set	C-130 Center Wing Station		
	38 U.S.	105 U.S.	121 L.S.
Group I	.19	.24	.11
Group II	.25	.29	.21
Group III	.13	.24	.13
Group IV	.26	.32	.18
Whole Fleet	.48	.74	.42

Values of σ From C-130 Truncated Data Best Fits

Set	C-130 Center Wing Station		
	38 U.S.	105 U.S.	121 L.S.
Group I	.16	.20	.12
Group II	.22	.21	.37
Group III	.13	.17	.14
Group IV	.22	.29	.082
Whole Fleet	.32	.95	.46

TABLE XXXXI

PERCENT DIFFERENCE BETWEEN PROPOSED

AND

C-130 EMPIRICAL SHAPE PARAMETERS

(Ref. Table XXXX)

Weibull Distribution Proposed α = 4.0

Values of α From C-130 Complete Data Best Fits			
Set	C-130 Center Wing Station		
	38 U.S.	105 U.S.	121 L.S.
Whole Fleet	10.2	52.7	25.0
Group 1	-56.2	-48.1	-65.8
Group 2	-38.5	-31.0	-36.5
Group 3	-76.3	-54.0	-60.4
Group 4	-42.9	-29.9	-42.9

Values of α From C-130 Truncated Data Best Fits			
Set	C-130 Center Wing Station		
	38 U.S.	105 U.S.	121 L.S.
Whole Fleet	-41.2	66.7	-2.4
Group 1	-64.9	-59.6	-73.2
Group 2	-51.8	-52.4	-18.4
Group 3	-76.3	-69.0	-66.4
Group 4	-51.2	-40.3	-80.7

TABLE XXXXI (CONTINUED)

PERCENT DIFFERENCE BETWEEN PROPOSED

AND

C-130 EMPIRICAL SHAPE PARAMETERS

(Ref. Table XXXX)

Log Normal Distribution Proposed σ = .322

Values of σ From C-130 Complete Data Best Fits			
Set	C-130 Center Wing Station		
	38 U.S.	105 U.S.	121 L.S.
Whole Fleet	-32.9	-56.5	-23.3
Group 1	69.5	34.2	192.7
Group 2	28.8	11.0	53.3
Group 3	147.7	34.2	147.7
Group 4	23.8	0.6	78.9

Values of σ From C-130 Truncated Data Best Fits			
Set	C-130 Center Wing Station		
	38 U.S.	105 U.S.	121 L.S.
Whole Fleet	.6	-66.1	-30.0
Group 1	101.2	61.0	168.3
Group 2	46.4	53.3	-13.0
Group 3	147.7	89.4	130.0
Group 4	46.4	11.0	292.7

TABLE XXXXII

EXACT EXPECTED VALUES OF FATIGUE ENDURANCE FOR C-130 EMPIRICAL SHAPE PARAMETERS

Theoretical Prediction of Fatigue Endurance Versus Reliability for Empirical Values of Shape Parameter Based on Weibull Distribution for Weakest Fleet Member

$\bar{R}$	Whole Fleet 439 Aircraft			Group 1 102 Aircraft			Group 2 121 Aircraft			Group 3 92 Aircraft			Group 4 51 Aircraft		
	Wing Station			Wing Station			Wing Station			Wing Station			Wing Station		
	38	105	121	38	105	121	38	105	121	38	105	121	38	105	121
	α 3.6	α 2.6	α 3.2	α 9.13	α 7.7	α 11.7	α 6.5	α 5.8	α 6.3	α 16.9	α 8.7	α 10.1	α 7.0	α 5.7	α 7.0
.5	1,777	701	847	6,920	4,560	3,798	5,196	3,523	2,634	9,398	5,004	3,604	6,279	4,032	3,216
.75	1,365	480	601	6,237	4,012	3,458	4,490	2,973	2,213	8,885	4,468	3,233	5,483	3,392	2,749
.95	837	242	337	5,141	3,182	2,953	3,423	2,186	1,651	8,004	3,640	2,693	4,262	2,481	2,112

TABLE XXXXIII

SUMMARY OF DISTRIBUTIONS OF C-130 CALCULATED AND EMPIRICAL TIMES TO CRACK INITIATION

(Ref. Figures 1 through 87)

Weibull Distribution

Set	Percentile	Empirical Distribution	Best Fit Distribution				Test Distribution	Adjusted Test Distribution
			Complete Data		Truncated Data			
			Assumed α	Empirical α	Assumed α	Empirical α		
Whole Fleet								
W.S. 38 u.s.	2	3,700	3,300	2,900	3,000	3,500	3,900	
	10	4,300	4,700	4,700	4,600	4,500	6,000	
	30	7,000	6,400	6,600	6,300	5,300	8,100	
W.S. 105 u.s.	2	3,800	3,300	2,500	3,200	2,600	3,000	
	10	4,500	5,000	5,000	4,800	5,200	4,600	
	30	7,900	6,800	7,800	6,600	8,500	6,200	
W.S. 121 l.s.	2	1,700	1,950	1,700	1,950	1,950	2,100	
	10	3,100	3,100	2,800	2,900	2,900	3,200	
	30	3,800	4,200	4,100	4,000	4,000	4,300	
Group 1								
W.S. 38 u.s.	2	6,700	5,000	6,200	4,800	6,400	3,900	13,700
	10	7,100	7,000	7,400	7,200	7,300	6,000	
	30	8,300	9,500	8,400	9,600	8,100	8,100	
W.S. 105 u.s.	2	6,300	5,000	6,100	5,200	6,300	3,000	13,100
	10	7,500	7,800	7,700	7,800	7,700	4,600	
	30	10,500	10,500	9,000	10,500	8,500	6,200	
W. S. 121 l.s.	2	6,100	3,300	5,600	3,700	5,900	2,320	4,300
	10	6,500	5,300	6,500	6,100	6,600	3,100	6,700
	30	7,200	7,100	7,400	8,300	7,200	4,400	9,000

TABLE XXXXIII

SUMMARY OF DISTRIBUTIONS OF C-130 CALCULATED AND EMPIRICAL TIMES TO CRACK INITIATION

(Ref. Figures 1 through 87)

Weibull Distribution (continued)

Set	Percentile	Empirical Distribution	Best Fit Distribution: Complete Data, Assumed α	Best Fit Distribution: Complete Data, Empirical α	Best Fit Distribution: Truncated Data, Assumed α	Best Fit Distribution: Truncated Data, Empirical α	Test Distribution	Adjusted Test Distribution
Group 2								
W.S. 38 u.s.	2	3,300	2,500	3,000	2,500	3,200	3,900	7,500
	10	4,100	3,600	3,900	3,700	3,900	5,900	11,800
	30	4,500	4,900	4,600	5,000	4,600	8,100	
W.S. 105 u.s.	2	3,700	2,800	3,300	2,800	3,500	3,000	7,000
	10	4,400	4,100	4,300	4,200	4,400	4,500	10,800
	30	5,100	5,600	5,300	5,600	5,100	6,200	14,500
W.S. 121 l.s.	2	2,500	1,700	2,400	1,900	2,200	2,100	1,000
	10	3,500	2,700	3,100	3,000	3,100	3,200	1,500
	30	3,900	3,700	3,800	4,100	4,000	4,300	2,100
Group 3								
W.S. 38 u.s.	2	4,200	3,700	4,100	3,700	4,200	3,900	11,000
	10		5,600	4,500	5,500	4,500		
	30			4,800		4,800		
W.S. 105 u.s.	2	3,800	3,300	3,600	3,200	3,700	3,200	9,500
	10	4,300	4,700	4,400	4,800	4,200	4,600	14,500
	30			5,000		4,600		
W.S. 121 l.s.	2	2,500	1,600	2,300	1,900	2,500	2,200	1,700
	10	2,800	2,200	2,800	2,500	2,800	3,200	2,700
	30	3,100	3,000	3,200	3,400	3,100	4,300	3,600

TABLE XXXXIII

SUMMARY OF DISTRIBUTIONS OF C-130 CALCULATED AND EMPIRICAL TIMES TO CRACK INITIATION

(Ref. Figures 1 through 87)
Weibull Distribution (continued)

Set	Percentile	Empirical Distribution	Best Fit Distribution				Test Distribution	Adjusted Test Distribution
			Complete Data		Truncated Data			
			α Assumed	α Empirical	α Assumed	α Empirical		
Group 4								
W. S. 38 u.s.	2	3,900	2,900	3,500	3,100	3,500	3,900	10,000
	10	4,200	4,300	4,300	4,300	4,300	6,000	
	30		5,300	5,100	5,800	5,000	8,100	
W.S. 105 u.s.	2	4,100	[illegible]	3,500	3,500	3,600	3,100	9,000
	10	4,500	4,700	4,700	4,700	[illegible]	4,600	14,000
	30		6,300	5,700	6,400	5,500	6,200	
W.S. 121 l.s.	2	4,600	2,300	[illegible]	2,500	3,500	2,400	3,000
	10	3,800	3,100	3,500	[illegible]	3,900	3,200	4,700
	30	4,000	4,200	4,200	4,600	4,000	4,300	6,300

TABLE XXXXIII (continued)

SUMMARY OF DISTRIBUTIONS OF C-130 CALCULATED AND EMPIRICAL TIMES TO CRACK INITIATION

(Ref. Figures 1 through 87)

σ Normal Distribution

Set	Percentile	Empirical Distribution	Best Fit Distributions: Complete Data, Assumed σ	Best Fit Distributions: Complete Data, Empirical σ	Best Fit Distributions: Truncated Data, Assumed σ	Best Fit Distributions: Truncated Data, Empirical σ	Test Distribution	Adjusted Test Distribution
Whole Fleet								
W.S. 38 u.s.	2	3,700	3,700	3,100	5,600	5,600	4,300	
	10	4,300	4,800	4,500	4,400	4,400	5,400	
	30	7,000	6,100	6,500	3,400	3,400	6,900	
W.S. 105 u.s.	2	3,800	3,900	2,600	3,500	2,400	3,600	
	10	4,500	4,900	4,700	4,500	5,100	4,700	
	30	7,900	6,200	8,200	5,800	10,500	6,000	
W.S. 121 l.s.	2	1,700	2,400	2,100	2,300	1,900	2,900	
	10	3,100	3,100	2,800	2,900	2,800	3,700	
	30	3,800	4,000	3,800	3,800	4,000	4,700	
Group 1								
W.S. 38 u.s.	2	6,700	5,500	6,300	5,400	6,400	4,300	15,000
	10	7,100	7,000	7,300	7,100	7,200	5,500	
	30	8,300	8,900	8,400	9,000	8,200	7,000	
W.S. 105 u.s.	2	6,300	5,700	6,300	5,900	6,400	3,800	
	10	7,500	7,600	7,600	7,600	7,500	4,700	
	30	10,500	9,600	9,000	9,600	8,800	6,000	
W.S. 121 l.s.	2	6,100	4,300	6,000	4,700	6,100	2,900	5,900
	10	6,500	5,200	6,500	6,100	6,500	3,700	7,800
	30	7,200	6,700	7,200	7,800	7,200	4,700	

TABLE XXXXIII

SUMMARY OF DISTRIBUTIONS OF C-130 CALCULATED AND EMPIRICAL TIMES TO CRACK INITIATION

(Ref. Figures 1 through 87)
Log Normal Distribution (continued)

Set	Percentile	Empirical Distribution	Best Fit Distributions				Test Distribution	Adjusted Test Distribution
			Complete Data		Truncated Data			
			Assumed σ	Empirical σ	Assumed σ	Empirical σ		
Group 2 W. S. 38 u.s.	2	3,300	2,300	3,000	2,300	3,300	4,300	5,300
	10	4,100	3,700	3,900	3,700	3,900	5,300	11,500
	50	4,500	4,700	4,700	4,700	4,400	7,000	
W.S. 105 u.s.	2	3,700	3,200	3,100	3,200	3,700	3,600	8,500
	[illegible]	4,100	4,200	[illegible]	4,100	[illegible]	4,800	11,000
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6,000	
W.S. [illegible]	[illegible]	[illegible]	2,100	[illegible]	2,500	[illegible]	2,500	1,400
	[illegible]	[illegible]	2,700	[illegible]	3,000	[illegible]	3,700	1,300
	[illegible]	[illegible]	[illegible]	[illegible]	4,000	[illegible]	[illegible]	[illegible]
[illegible]	2	[illegible]	3,900	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]		5,000	4,600	[illegible]	4,600	5,400	
	[illegible]			5,100		5,100		
[illegible]	[illegible]	[illegible]	[illegible]	3,600	[illegible]	3,700	3,700	11,000
	10	4,300	4,500	4,300	4,100	[illegible]	4,700	14,000
	[illegible]		5,700	5,200	5,700	4,800		
[illegible] u.s	2	2,500	1,700	2,500	2,100	[illegible]	2,400	2,400
	10	2,800	2,200	2,900	2,500	[illegible]	3,700	3,100
	[illegible]	3,100	2,800	3,100	3,300	3,100	4,700	4,000

TABLE XXXXIII

SUMMARY OF DISTRIBUTIONS OF C-130 CALCULATED AND EMPIRICAL TIMES TO CRACK INITIATION

(Ref. Figures 1 through 87)
Log Normal Distribution (continued)

Set	Percentile	Empirical Distribution	Best Fit Distribution				Test Distribution	Adjusted Test Distribution
			Complete Data		Truncated Data			
			Assumed σ	Empirical σ	Assumed σ	Empirical σ		
Group 4								
W. S. 38 u.s.	2	3,900	3,300	3,500	3,300	3,500	4,200	11,[illegible]
	10	4,200	4,200	4,300	4,200	4,200	5,400	14,[illegible]
	30		5,400	5,200	5,400	5,000	6,900	
W. S. 105 u.s.	2	4,100	3,500	3,500	3,400	3,600	3,700	11,[illegible]
	10	4,500	4,600	4,600	4,600	4,600	4,700	
	30		5,900	5,900	5,900	5,700	6,000	
W.S. 121 l.s.	2	3,600	2,200	3,000	2,600	3,500	2,900	4,[illegible]
	10	3,800	3,000	3,600	3,400	3,800	3,700	5,[illegible]
	30	4,000	3,900	4,100	4,400	4,000	4,700	

Table XXXXIV

PERCENT DIFFERENCES BETWEEN CALCULATED AND EMPIRICAL

DISTRIBUTIONS OF C-130 TIMES TO CRACK INITIATION

(Ref. Table XXXXIII)

Weibull Distribution

Set	%	Emp. Dist.	Best Fit Distribution: Complete Data, Assumed α	Best Fit Distribution: Complete Data, Empir. α	Best Fit Distribution: Truncated Data, Assumed α	Best Fit Distribution: Truncated Data, Empir. α	Test Dist.	Adj. Test Dist.
Whole Fleet WS 38	2	3,700	-10.8	-21.6	-18.9	- 5.4	5.4	
u.s.	10	4,300	9.3	9.3	7.0	4.7	39.5	
	30	7,000	- 8.6	- 5.7	-10.0	-24.3	15.7	
WS 105	2	3,800	-13.1	-34.2	-15.8	-31.6	-21.1	
u.s.	10	4,500	11.1	11.1	6.7	15.6	2.2	
	30	7,900	-13.9	- 1.3	-16.4	7.6	-21.5	
WS 121	2	1,700	14.7	0.0	14.7	14.7	23.5	
l.s.	10	3,100	0.0	- 3.7	- 6.4	- 6.4	3.2	
	30	3,800	10.5	7.9	5.3	5.3	13.1	
Group 1 WS 38	2	6,700	-25.4	- 7.5	-28.4	- 4.5	-41.8	104.5
u.s.	10	7,100	- 1.4	4.2	1.4	2.8	-15.5	
	30	8,300	14.4	1.2	18.1	- 2.4	- 2.4	
WS 105	2	6,300	-20.5	- 3.2	-27.5	0.0	-52.4	107.9
u.s.	10	7,500	4.0	2.7	4.0	2.7	-38.7	
	30	10,500	0.0	-14.3	0.0	-19.0	-41.0	
WS 121	2	6,100	-45.9	- 8.2	-33.3	- 3.3	-62.0	-29.5
l.s.	10	6,500	-18.5	0.0	- 6.2	1.5	-52.3	3.1
	30	7,200	- 1.4	2.8	15.3	0.0	-38.9	25.0
Group 2 WS 38	2	3,300	-24.2	- 9.1	-24.2	- 3.0	18.2	127.3
u.s.	10	4,100	-12.2	- 4.9	- 9.8	- 4.9	43.9	137.8
	30	4,500	3.9	2.2	11.1	2.2	80.0	
WS 105	2	3,700	-24.3	-10.8	-21.3	- 5.4	-18.9	89.2
u.s.	10	4,400	- 6.8	- 2.3	- 4.5	0.0	- 2.3	145.4
	30	5,100	9.8	3.9	9.9	0.0	21.6	184.3
WS 121	2	2,500	-32.0	- 4.0	-24.0	-12.0	-16.0	-60.0
l.s.	10	3,500	-22.8	-11.4	-14.3	-11.4	- 8.6	-57.1
	30	3.900	- 5.1	- 2.6	5.1	2.6	10.2	-46.2

TABLE XXXXIV

PERCENT DIFFERENCES BETWEEN CALCULATED AND EMPIRICAL

DISTRIBUTIONS OF C-130 TIMES TO CRACK INITIATION

Weibull Distribution (continued)

Set	%	Emp. Dist.	Best Fit Distributions				Test Dist.	Adj. Test Dist.
			Complete Data		Truncated Data			
			Assumed α	Empir. α	Assumed α	Empir. α		
Group 3								
WS 38	2	4,200	-11.9	- 2.4	-11.9	0.0	- 7.1	161.9
u.s.	10							
	30							
WS 105	2	3,800	-13.2	- 5.3	-15.8	- 2.6	-15.8	150.0
u.s.	10	4,300	9.3	2.3	11.6	- 2.3	7.0	237.2
	30							
WS 121								
l.s.	2	2,500	-36.0	- 8.0	-24.0	0.0	-12.0	-32.0
	10	2,800	-21.4	0.0	-10.7	0.0	14.3	- 3.6
	30	3,100	- 3.2	3.2	9.7	0.0	38.7	16.1
Group 4								
WS 38	2	3,900	-25.6	-10.2	-20.5	-10.2	0.0	156.4
u.s.	10	4,200	2.4	2.4	2.4	2.4	42.8	
	30							
WS 105	2	4,100	-22.0	-14.6	-19.5	-12.2	-24.4	119.5
u.s.	10	4,500	4.4	4.4	4.4	2.2	2.2	211.1
	30							
WS 121								
l.s.	2	3,600	-36.1	-22.2	-30.6	- 2.8	-33.3	-16.7
	10	3,800	-18.4	- 7.9	-10.5	0.0	-15.8	23.7
	30	4,000	5.0	5.0	15.0	0.0	7.5	57.5

TABLE XXXXIV (continued)

PERCENT DIFFERENCES BETWEEN CALCULATED AND EMPIRICAL

DISTRIBUTIONS OF C-130 TIMES TO CRACK INITIATION

(Ref. Table XXXXIII)

Log Normal Distribution

Set	%	Emp. Dist.	Best Fit Distribution: Complete Data: Assumed σ	Best Fit Distribution: Complete Data: Empir. σ	Best Fit Distribution: Truncated Data: Assumed σ	Best Fit Distribution: Truncated Data: Empir. σ	Test Dist.	Adj. Test Dist.
Whole Fleet	2	3,700	0.0	-16.2	51.4	51.4	16.2	
WS 38	10	4,300	11.6	4.6	2.3	2.3	25.6	
u.s.	30	7,000	-12.8	- 7.1	-51.4	-51.4	- 1.4	
WS 105	2	3,800	2.6	-31.6	- 7.9	-36.8	- 5.3	
u.s.	10	4,500	8.9	4.4	0.0	13.3	4.4	
	30	7,900	-21.5	3.8	-26.6	32.9	-24.0	
WS 121	2	1,700	41.2	23.5	35.2	11.8	70.6	
l.s.	10	3,100	0.0	- 9.7	- 6.4	- 9.7	19.4	
	30	3,800	5.3	0.0	0.0	5.3	23.7	
Group 1								
WS 38	2	6,700	-17.9	- 6.0	-19.4	- 4.5	-35.8	123.9
u.s.	10	7,100	- 1.4	2.8	0.0	1.4	-22.5	
	30	8,300	7.2	1.2	8.4	- 1.2	-15.7	
WS 105	2	6,300	- 9.5	0.0	- 6.3	1.6	-39.7	
u.s.	10	7,500	1.3	1.3	1.3	0.0	-37.3	
	30	10,500	- 8.6	-14.3	- 8.6	-16.2	-42.8	
WS 121	2	6,100	-34.4	- 1.6	-23.0	0.0	-52.4	- 3.3
l.s.	10	6,500	-20.0	0.0	- 6.2	0.0	-43.1	20.0
	30	7,200	- 6.9	0.0	8.3	0.0	-34.7	
Group 2								
WS 38	2	3,300	-12.1	- 9.1	-15.2	0.0	30.3	151.5
u.s.	10	4,100	- 9.8	- 4.9	- 9.8	- 4.9	34.1	168.3
	30	4,500	4.4	4.4	4.4	2.2	55.6	
WS 105	2	3,700	-13.5	- 8.1	-13.5	0.0	- 2.7	129.7
u.s.	10	4,400	- 4.5	- 2.3	- 6.8	- 2.3	9.1	150.0
	30	5,100	3.9	3.9	3.9	0.0	17.6	
WS 121	2	2,500	-16.0	4.0	- 8.0	- 4.0	12.0	-44.0
l.s.	10	3,500	-22.8	-11.4	-14.3	-11.4	5.7	-48.6
	30	3,900	-10.2	- 5.1	2.6	2.6	23.1	-41.0

TABLE XXXXIV

PERCENT DIFFERENCES BETWEEN CALCULATED AND EMPIRICAL DISTRIBUTIONS OF C-130 TIMES TO CRACK INITIATION

Log Normal Distribution (continued)

Set	%	Emp. Dist.	Best Fit Distribution: Complete Data: Assumed σ	Complete Data: Empir. σ	Truncated Data: Assumed σ	Truncated Data: Empir. σ	Test Dist.	Adj. Test Dist.
Group 3								
WS 38	2	4,200	- 9.5	- 2.4	- 7.1	- 2.4	2.4	150.0
u.s.	10							
	30							
WS 105	2	3,800	- 5.3	- 5.3	-10.5	- 2.6	- 2.6	189.5
u.s.	10	4,300	4.6	0.0	2.3	- 2.3	9.3	225.6
	30							
WS 121	2	2,500	-32.0	0.0	-16.0	0.0	12.0	- 4.0
l.s.	10	2,800	-21.4	0.0	-10.7	0.0	32.1	10.7
	30	3,100	- 9.7	0.0	6.4	0.0	51.6	39.0
Group 4								
WS 38	2	3,900	-15.4	-10.2	-15.4	-10.2	7.7	182.0
u.s.	10	4,200	0.0	2.4	0.0	0.0	28.6	233.3
	30							
WS 105	2	4,100	-14.6	-14.6	-17.1	-12.2	9.8	180.4
u.s.	10	4,500	2.2	2.2	2.2	2.2	4.4	
	30							
WS 121	2	3,600	-39.9	-16.7	-27.8	- 2.8	-19.4	16.7
l.s.	10	3,800	-21.0	- 5.3	-10.5	0.0	- 2.6	42.1
	30	4,000	- 2.5	2.5	10.0	0.0	17.5	

TABLE [illegible]

PERCENT DIFFERENCES BETWEEN C-130 BEST FIT DISTRIBUTIONS
WITH ASSUMED AND EMPIRICAL SHAPE PARAMETERS
(Ref. Table XXXXIV)
Weibull Distribution

Set	Percentile	Best Fit Distribution	
		Complete Data	Truncated Data
Whole Fleet			
W. S. 38 u. s.	2	13.8	-14.3
	10	0.0	2.2
	30	- 3.0	18.9
W. S. 105 u. s.	2	32.0	23.1
	10	0.0	- 7.7
	30	-12.8	-22.4
W. S. 121 l. s.	2	14.7	0.0
	10	10.7	0.0
	30	2.4	0.0
Group 1			
W. S. 38 u. s.	2	-19.4	-25.0
	10	- 5.4	- 1.4
	30	13.1	21.0
W. S. 105 u. s.	2	-18.0	-17.5
	10	1.3	1.3
	30	16.7	23.5
W. S. 121 l. s.	2	-14.1	-37.3
	10	-18.5	- 7.6
	30	- 4.1	15.3
Group 2			
W. S. 38 u. s.	2	-16.7	-21.9
	10	- 7.7	- 5.1
	30	6.5	8.7
W. S. 105 u. s.	2	-15.2	-20.0
	10	- 4.7	- 4.6
	30	5.7	9.8
W. S. 121 l. s.	2	-29.2	-13.6
	10	-12.9	- 3.2
	30	- 2.6	2.5
Group 3			
W. S. 38 u. s.	2	- 9.8	-11.9
	10	24.4	22.2
	30	-	-
W. S. 105 u. s.	2	- 8.3	-13.5
	10	6.8	14.3
	30	-	-
W. S. 121 l. s.	2	-30.4	-24.0
	10	-21.4	-10.7
	30	- 6.3	9.7
Group 4			
W. S. 38 u. s.	2	-17.1	-11.4
	10	0.0	0.0
	30	13.7	16.0
W. S. 105 u. s.	2	- 8.6	- 8.3
	10	0.0	2.2
	30	10.5	16.4
W. S. 121 l. s.	2	-17.9	-28.6
	10	-11.4	-10.5
	30	0.0	15.0

TABLE XXXXV (CONTINUED)
PERCENT DIFFERENCES BETWEEN C-130 BEST FIT DISTRIBUTIONS
WITH ASSUMED AND EMPIRICAL SHAPE PARAMETERS
(Ref. Table XXXXIV)
Log Normal Distribution

Set	Percentile	Best Fit Distribution	
		Complete Data	Truncated Data
Whole Fleet			
W. S. 38 u. s.	2	19.4	0.0
	10	6.7	0.0
	30	- 6.2	0.0
W. S. 105 u. s.	2	50.0	45.8
	10	4.3	-11.8
	30	-24.4	-44.8
W. S. 121 l. s.	2	14.3	21.1
	10	10.7	3.6
	30	5.3	- 5.0
Group 1			
W. S. 38 u. s.	2	-12.7	-15.6
	10	- 4.1	- 1.4
	30	6.0	9.8
W. S. 105 u. s.	2	- 9.6	- 7.8
	10	0.0	1.3
	30	6.7	9.1
W. S. 121 l. s.	2	-33.3	-23.0
	10	-20.0	- 6.2
	30	- 6.9	8.3
Group 2			
W. S. 38 u. s.	2	- 3.3	-15.2
	10	- 5.1	- 5.1
	30	0.0	2.2
W. S. 105 u. s.	2	- 5.9	-13.5
	10	- 2.3	- 4.7
	30	0.0	3.9
W. S. 121 l. s.	2	-19.2	- 4.2
	10	-12.9	- 3.2
	30	- 5.4	0.0
Group 3			
W. S. 38 u. s.	2	- 7.3	- 4.9
	10	8.7	8.7
	30	-	-
W. S. 105 u. s.	2	0.0	- 8.1
	10	4.7	4.8
	30	9.6	18.8
W. S. 121 l. s.	2	-32.0	-16.0
	10	-21.4	-10.7
	30	- 9.7	6.5
Group 4			
W. S. 38 u. s.	2	- 5.7	- 5.7
	10	- 2.3	0.0
	30	3.8	8.0
W. S. 105 u. s.	2	0.0	- 5.6
	10	0.0	0.0
	30	0.0	3.5
W. S. 121 l. s.	2	-26.7	-25.7
	10	-16.7	-10.5
	30	- 4.9	10.0

TABLE XXXXVI

NUMBER OF PERCENT DIFFERENCES IN C-130 TIMES TO CRACK INITIATION GREATER THAN 10%

Case	With Respect To: Values Empirical Distribution														With Respect To: Values of Best Fit Empirical								Totals		Possible Totals	
	Best Fit Distributions								Test Dist.		Sub Totals		Possible Number Values		Best Fit Distributions				Sub Totals		Possible Number Values					
	Complete Data				Truncated Data										Complete Data		Truncated Data									
	Assum. σ α		Empir. σ α		Assum. σ α		Empir. σ α																			
	LN	W	LN	W	LN	W	LN	W	LN	W	LN	W	LN	W	LN	W	LN	W	LN	W	LN	W	LN	W	LN	W
Total	18	24	8	9	17	25	10	9	27	29	80	96	200	200	14	23	14	25	28	48	88	86	108	144	288	[illegible]
Wh. Fl.	4	6	3	3	4	5	6	4	6	6	23	24	45	45	5	5	4	4	9	9	18	18	32	33	63	[illegible]
Gp. 1	3	5	1	1	2	5	1	1	9	8	16	20	45	45	3	6	2	6	5	12	18	18	21	32	63	[illegible]
Gp. 2	5	5	1	2	3	5	1	2	6	7	16	21	45	45	2	4	2	3	4	7	18	18	20	28	63	[illegible]
Gp. 3	2	4	0	0	3	5	0	0	3	4	8	13	30	30	2	3	3	6	5	9	16	14	13	22	46	44
Gp. 4	4	4	3	3	5	5	2	2	3	4	17	18	35	35	2	5	3	6	5	11	18	18	22	29	63	[illegible]
Percent																										
2	10	15	6	6	11	15	5	5	9	12	41	53	75	75	8	12	8	13	16	25	30	30	57	78	105	105
10	5	6	1	2	3	4	2	2	8	8	19	22	70	70	5	6	3	4	8	10	30	30	27	32	100	100
30	3	3	1	1	3	6	3	2	10	9	20	21	55	55	1	5	3	8	4	13	28	26	24	34	81	[illegible]
W. S.																										
38 u.s.	5	7	2	2	5	8	3	2	9	8	24	27	60	60	2	7	2	9	4	16	28	28	28	43	88	88
105 u.s.	3	7	3	5	4	7	5	4	5	9	20	32	65	65	2	6	5	8	7	14	30	28	27	46	95	[illegible]
121 u.s.	10	10	3	2	8	10	2	3	13	12	36	37	75	75	10	10	7	8	17	18	30	30	53	55	105	105

TABLE XXXXVII
NUMBER OF PERCENT DIFFERENCES IN C-130 TIMES TO CRACK INITIATION GREATER THAN 20%

Case	With Respect To: Values of Empirical Distribution														With Respect To: Values of Best Fit Empirical								Totals		Possible Totals	
	Best Fit Distribution								Test Dist.		Sub Total		Possible Number Values		Best Fit Distribution				Sub Total		Possible Number Values					
	Complete Data				Truncated Data										Complete Data		Truncated Data									
	Assum. σ α		Empir. σ α		Assum. σ α		Empir. σ α																			
	LN	W	LN	W	LN	W	LN	W	LN	W	LN	W	LN	W	LN	W	LN	W	LN	W	LN	W	LN	W	LN	W
Total	8	12	2	3	6	8	4	2	19	18	39	43	200	200	6	6	5	10	11	16	88	86	50	59	288	286
Wh. Fl.	2	0	2	2	4	0	4	2	4	4	16	8	45	45	2	1	3	2	5	3	18	18	21	11	63	63
Op. 1	1	3	0	0	1	2	0	0	8	7	10	12	45	45	1	1	1	4	2	5	18	18	12	17	63	63
Op. 2	1	4	0	0	0	3	0	0	4	3	5	10	45	45	0	1	0	1	0	2	18	18	5	12	63	63
Op. 3	2	2	0	0	0	1	0	0	2	1	4	4	30	30	2	3	0	2	2	5	16	14	6	9	46	44
Op. 4	2	3	0	1	1	2	0	0	1	3	4	9	35	35	1	0	1	1	2	1	18	18	6	10	63	63
Percent																										
2	4	10	2	3	4	8	2	1	5	7	17	29	75	75	4	4	4	6	8	10	30	30	25	39	105	105
10	3	2	0	0	0	0	0	0	7	5	10	7	70	70	1	2	0	1	1	3	30	30	11	10	100	100
30	1	0	0	0	2	0	2	1	7	6	12	7	55	55	1	0	1	3	2	3	28	26	14	10	83	81
W. S.																										
38 u.s.	0	3	0	1	2	3	2	1	7	5	11	13	60	60	0	1	0	3	0	4	28	28	11	17	88	68
105 u.s.	1	3	1	1	1	1	2	1	4	7	9	13	65	65	2	1	2	4	4	5	30	28	13	18	95	93
121 L.s.	7	6	1	1	3	4	0	0	8	6	19	17	75	75	4	4	3	3	7	7	30	30	26	24	105	105

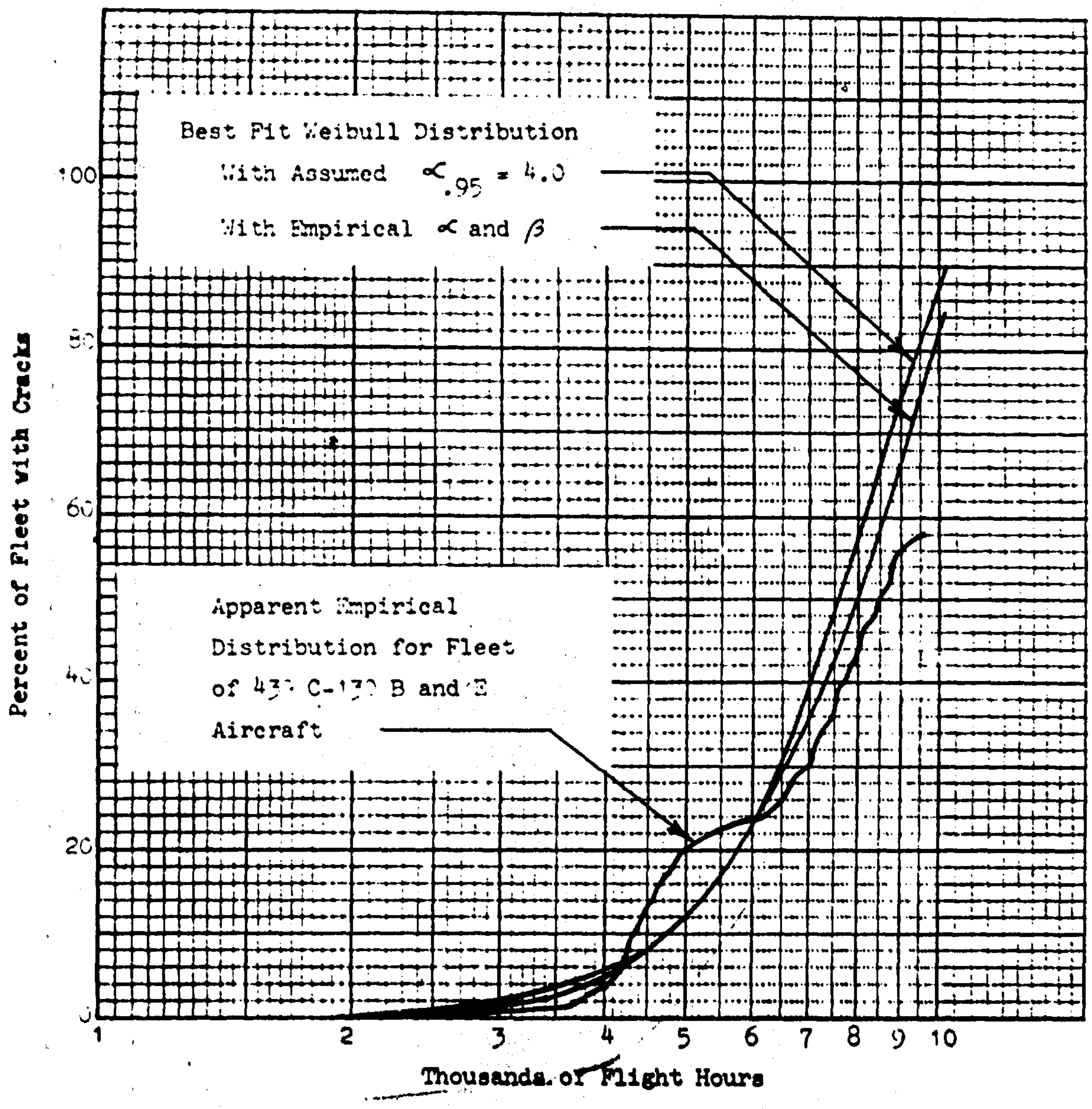


FIGURE 1 APPARENT AND BEST FIT WEIBULL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 38 FOR WHOLE FLEET

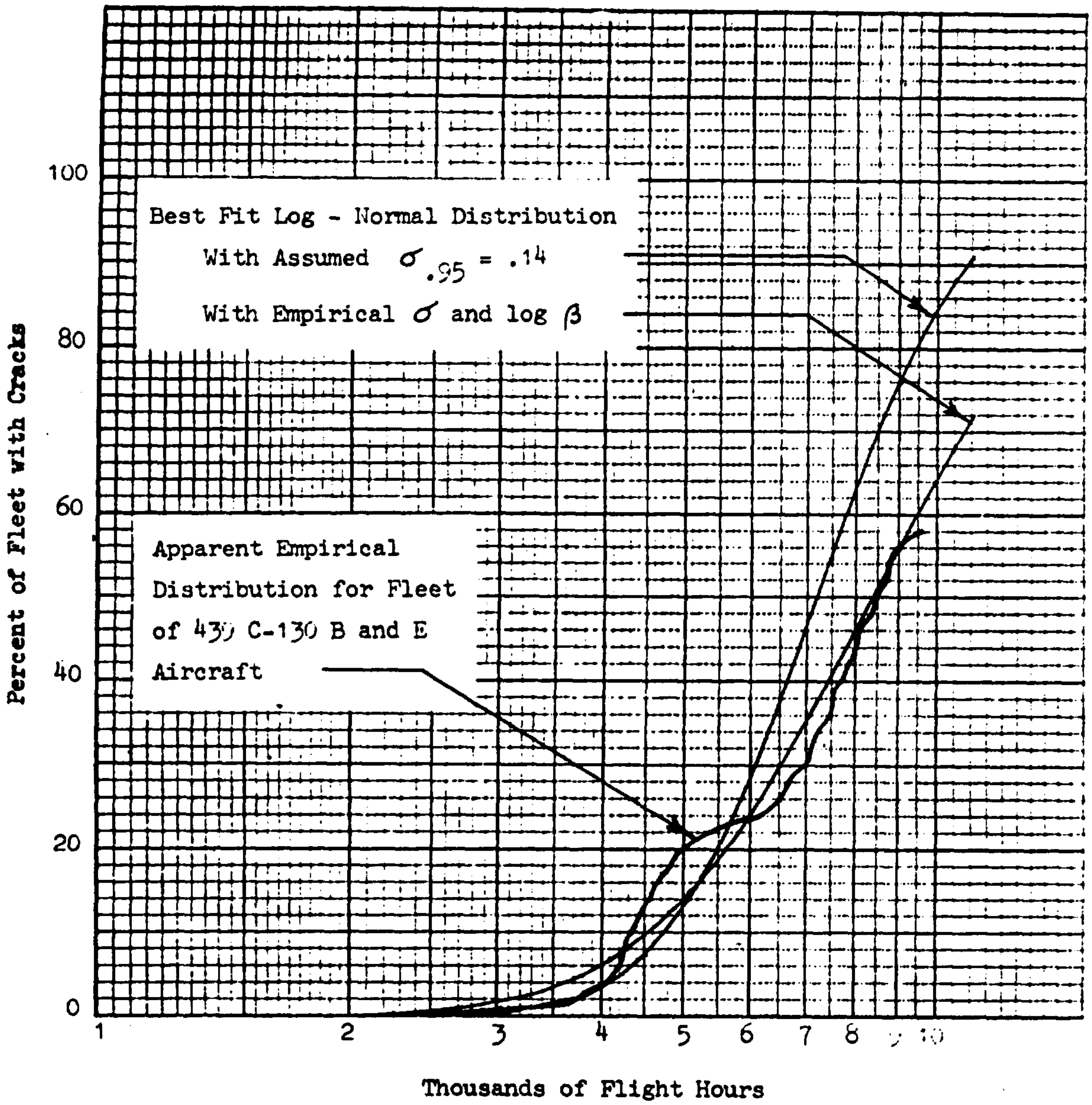


FIGURE 2 APPARENT AND BEST FIT LOG-NORMAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 38 FOR WHOLE FLEET

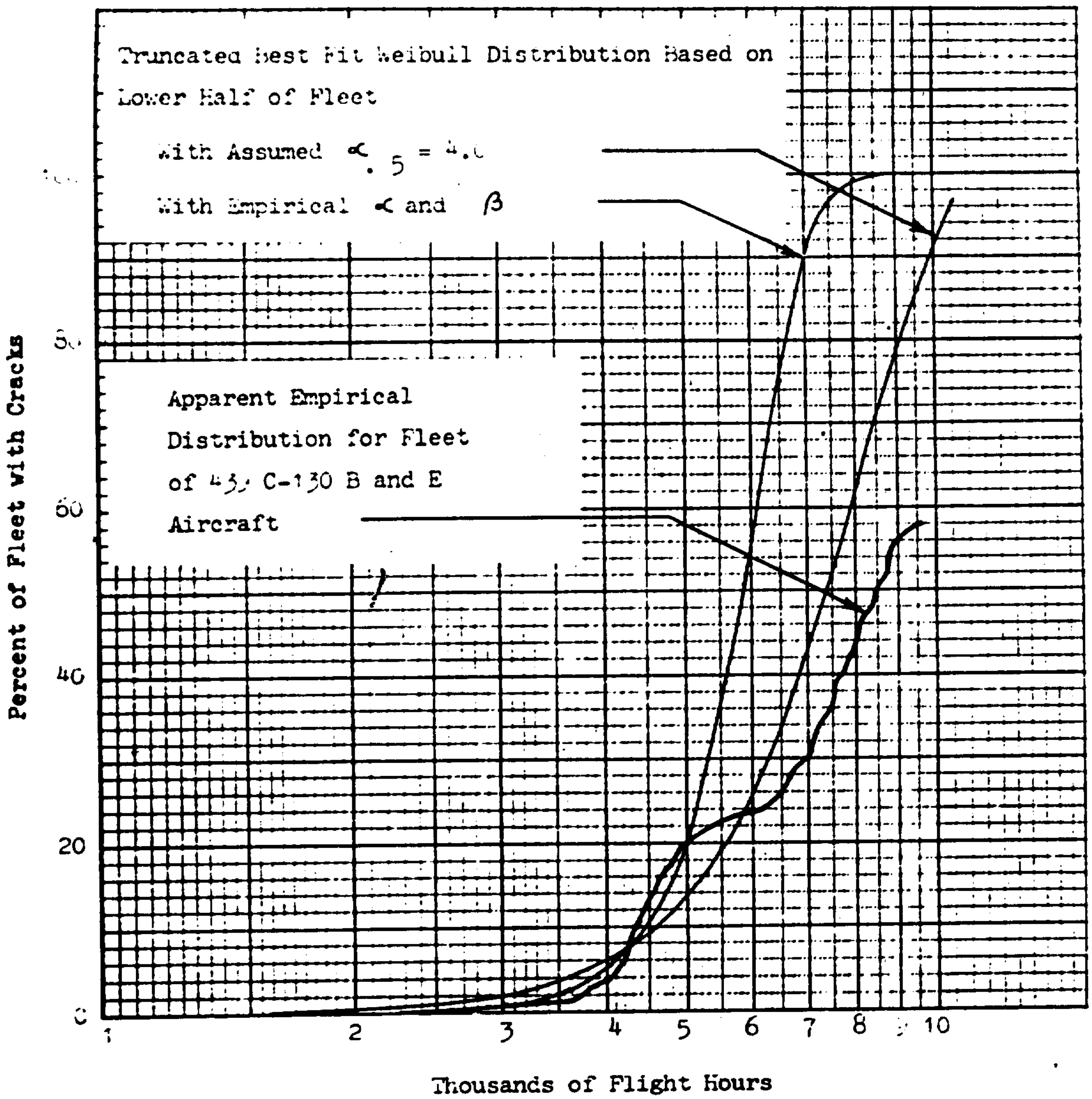


FIGURE 3 APPARENT AND TRUNCATED BEST FIT WEIBULL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 38 FOR WHOLE FLEET

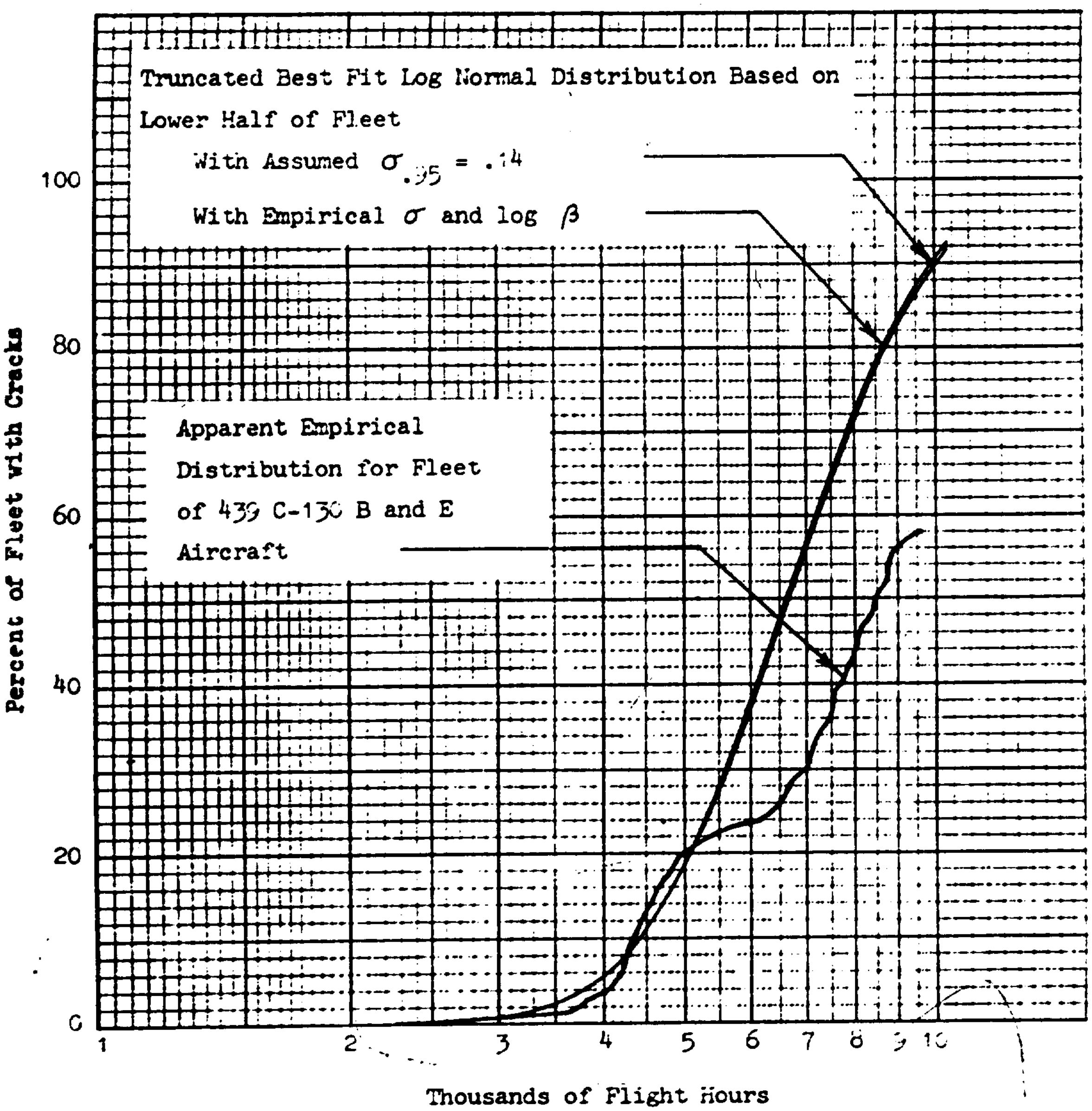


FIGURE 4 APPARENT AND TRUNCATED BEST FIT LOG-NORMAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 38 FOR WHOLE FLEET

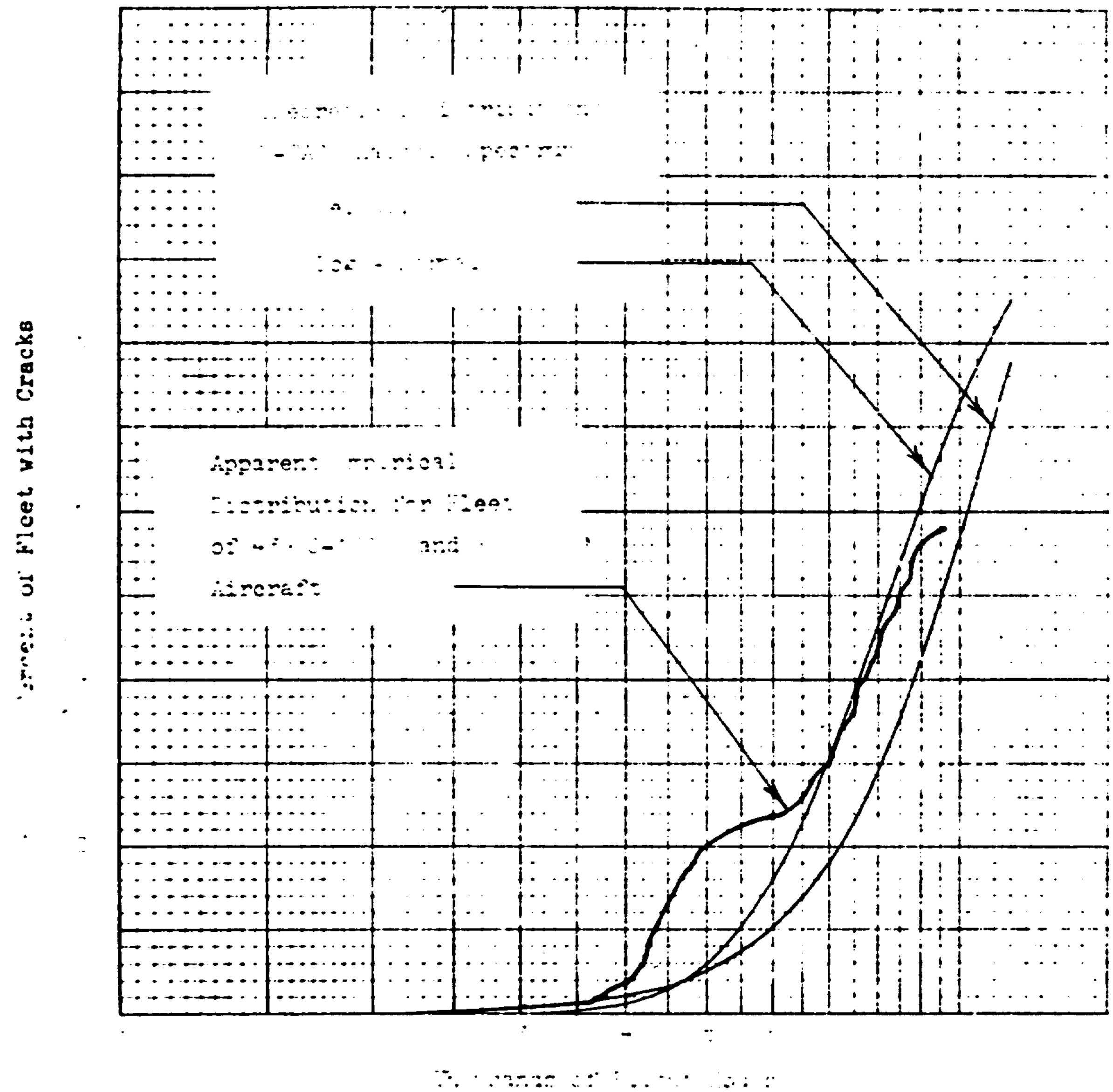


FIGURE 5 APPARENT AND THEORETICAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 38 FOR WHOLE FLEET

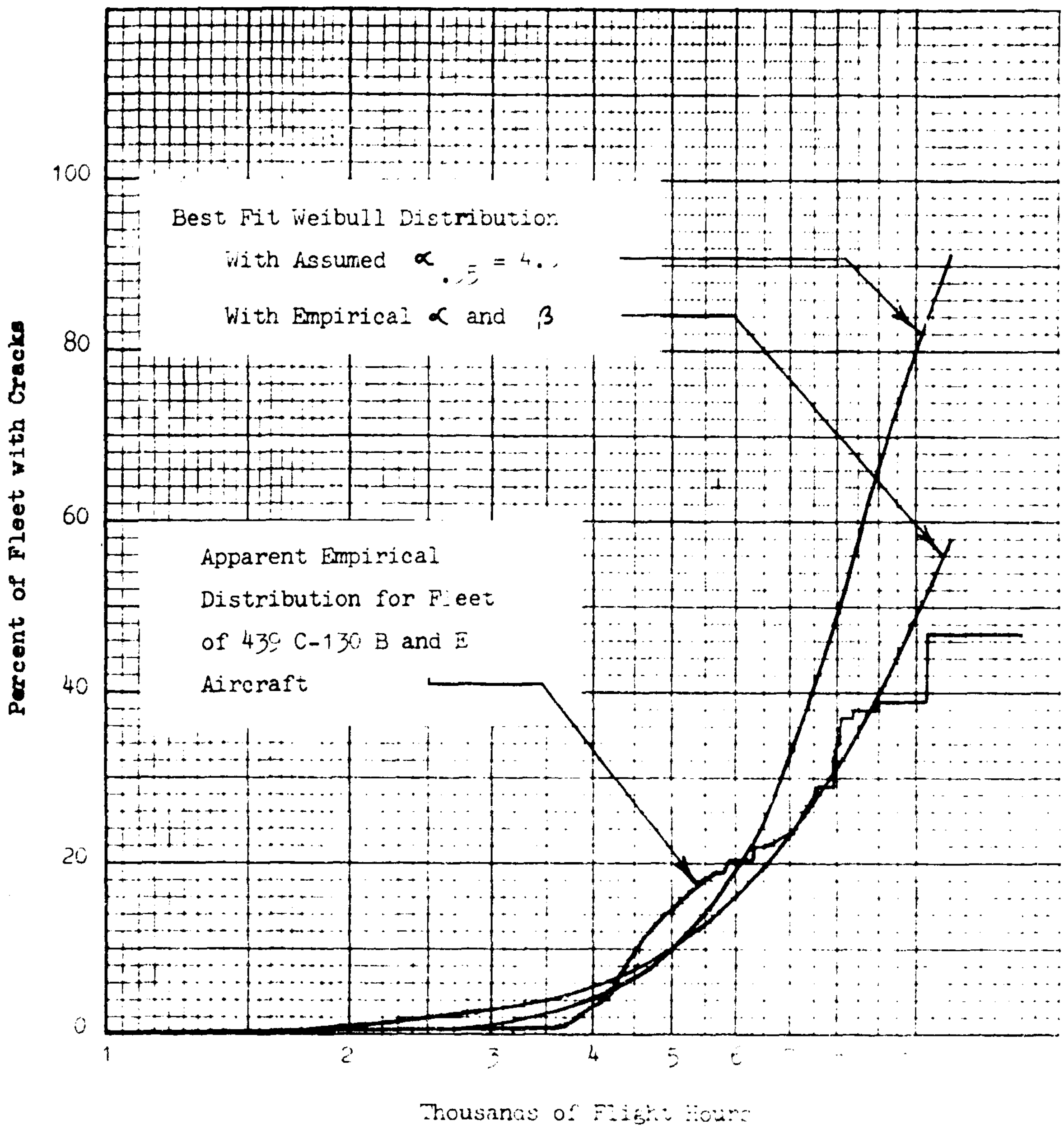


FIGURE 6 APPARENT AND BEST FIT WEIBULL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 105 FOR WHOLE FLEET

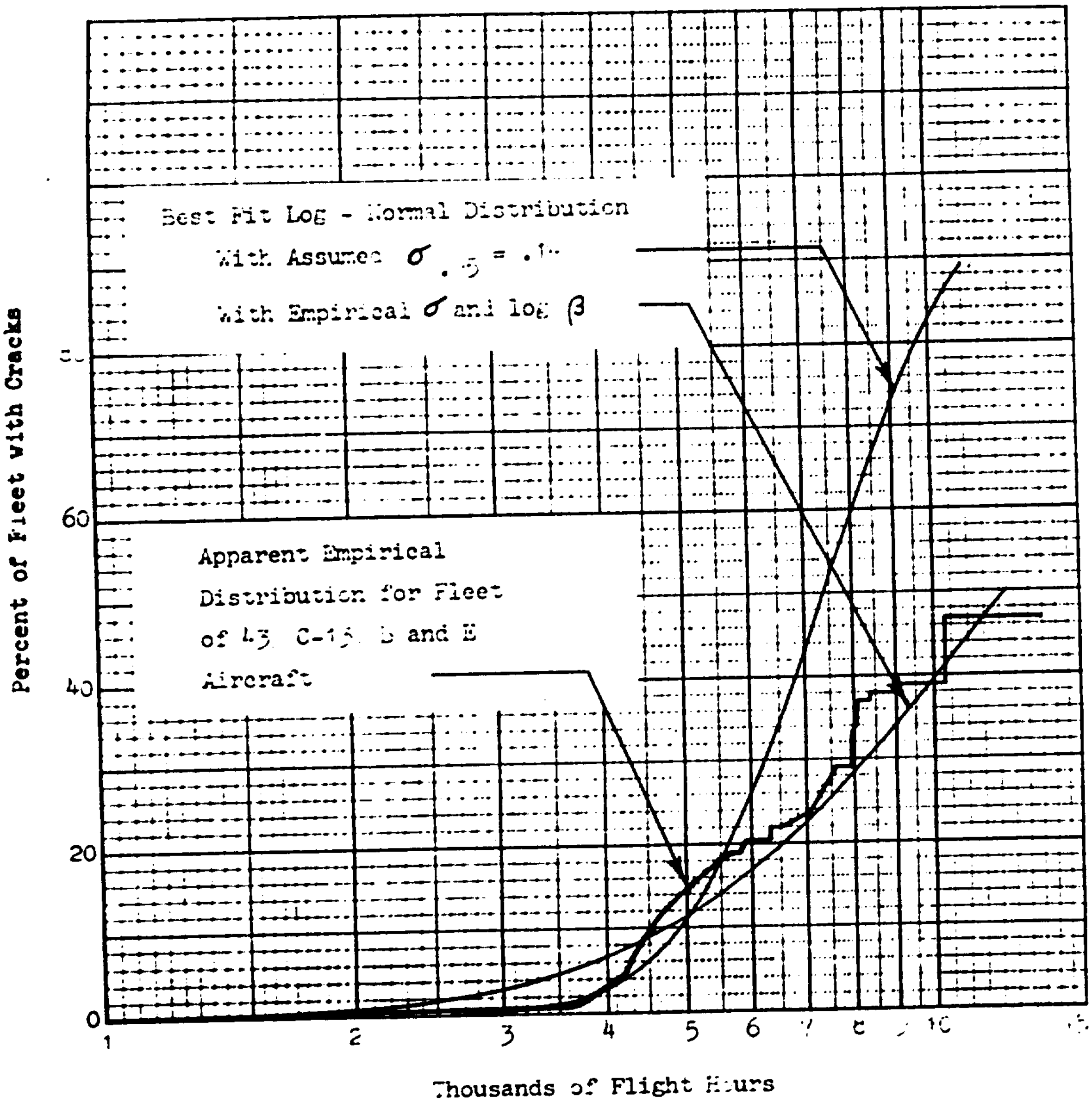


FIGURE 7 APPARENT AND BEST FIT LOG-NORMAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 105 FOR WHOLE FLEET

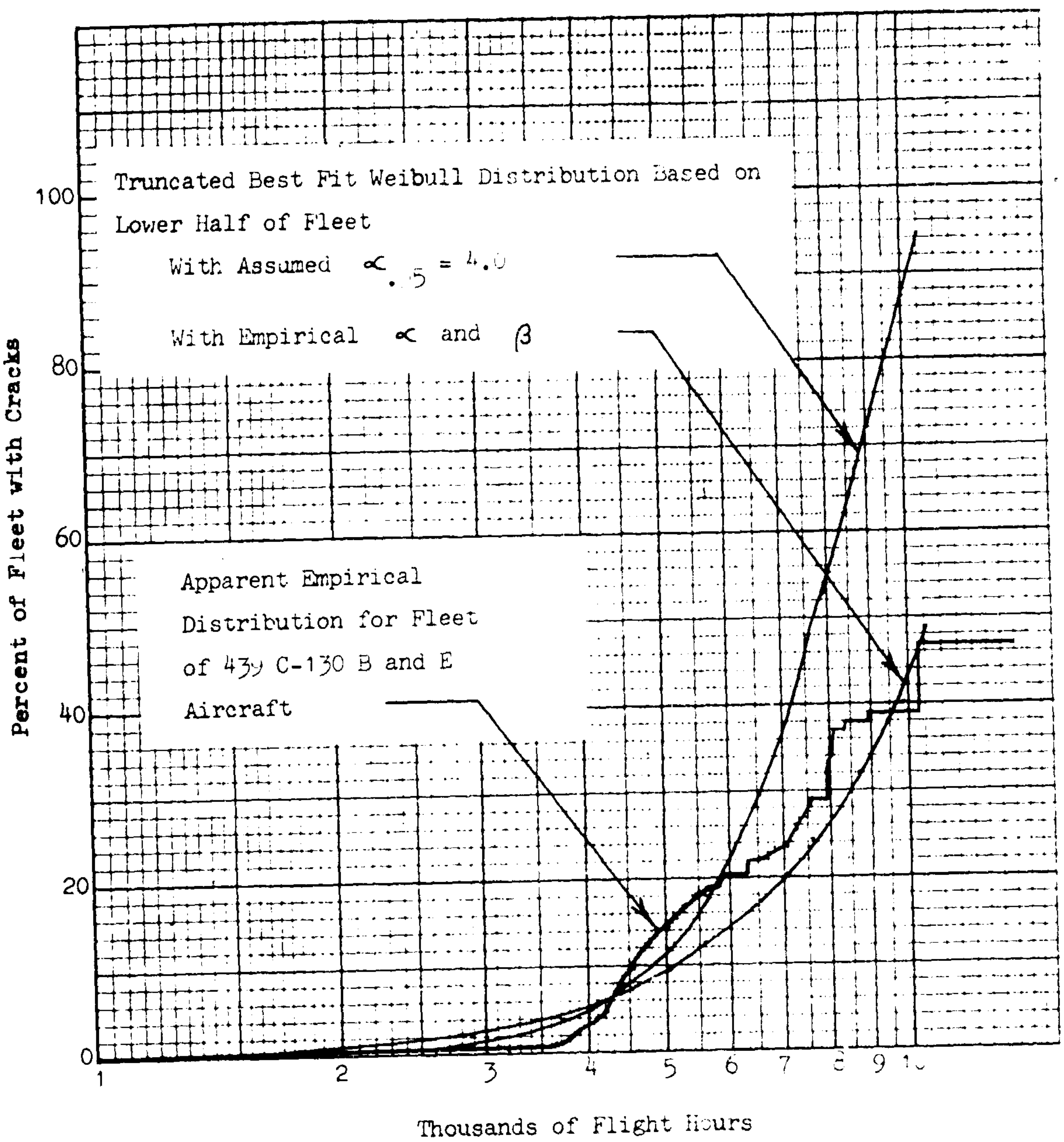


FIGURE 8 APPARENT AND TRUNCATED BEST FIT WEIBULL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 105 FOR WHOLE FLEET

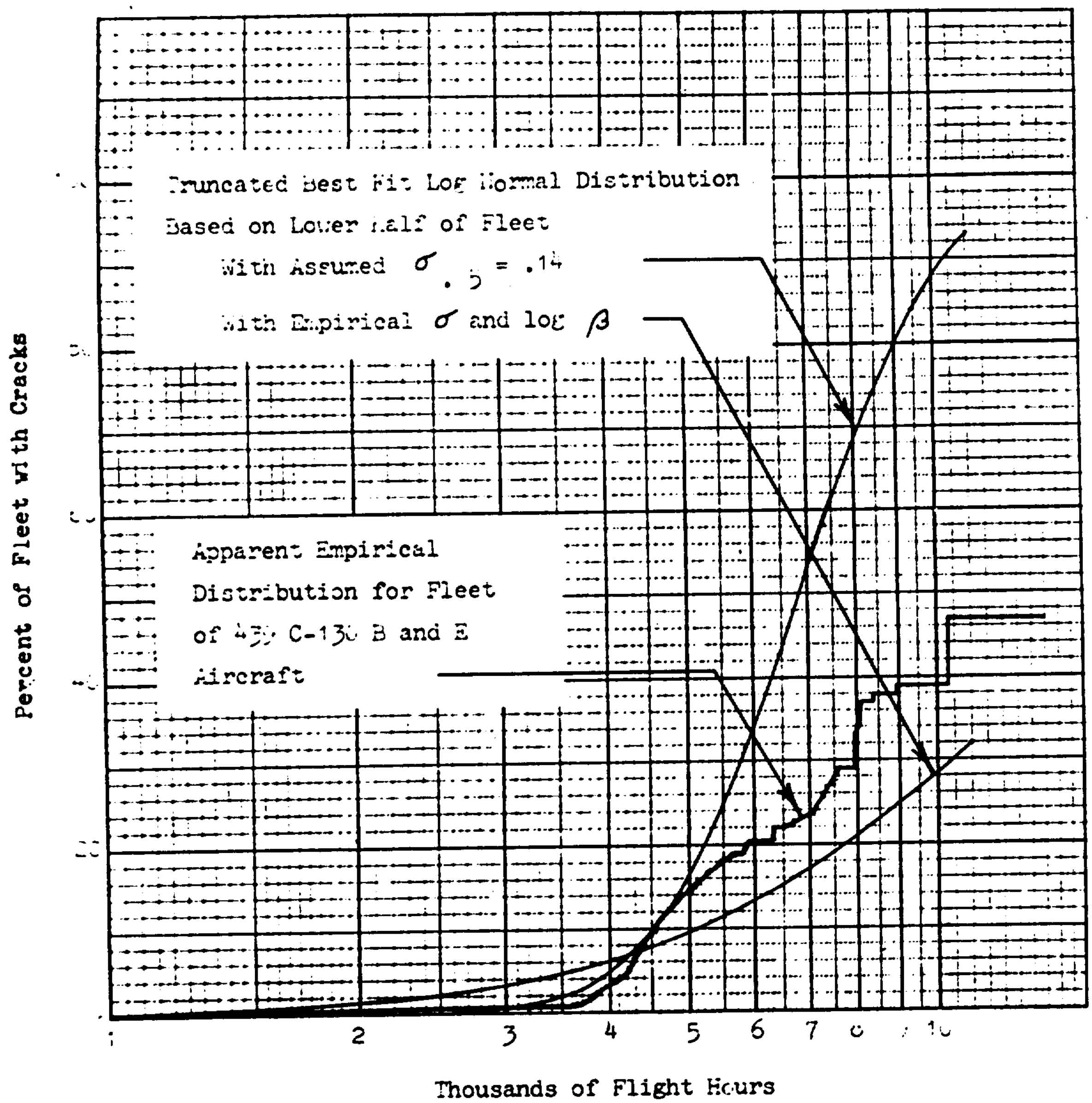


FIGURE 9 APPARENT AND TRUNCATED BEST FIT LOG-NORMAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 105 FOR WHOLE FLEET

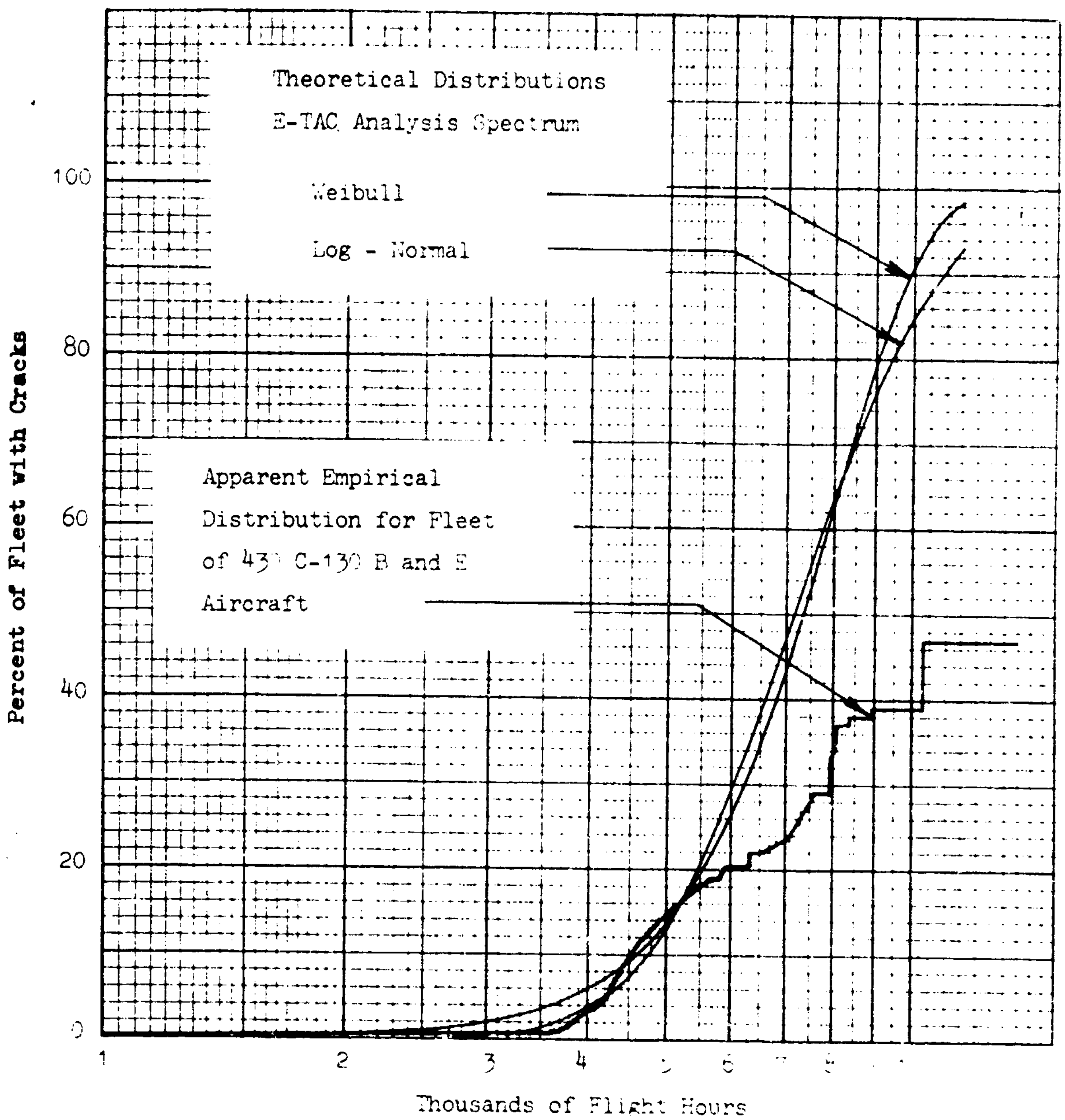


FIGURE 10 APPARENT AND THEORETICAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 105 FOR WHOLE FLEET

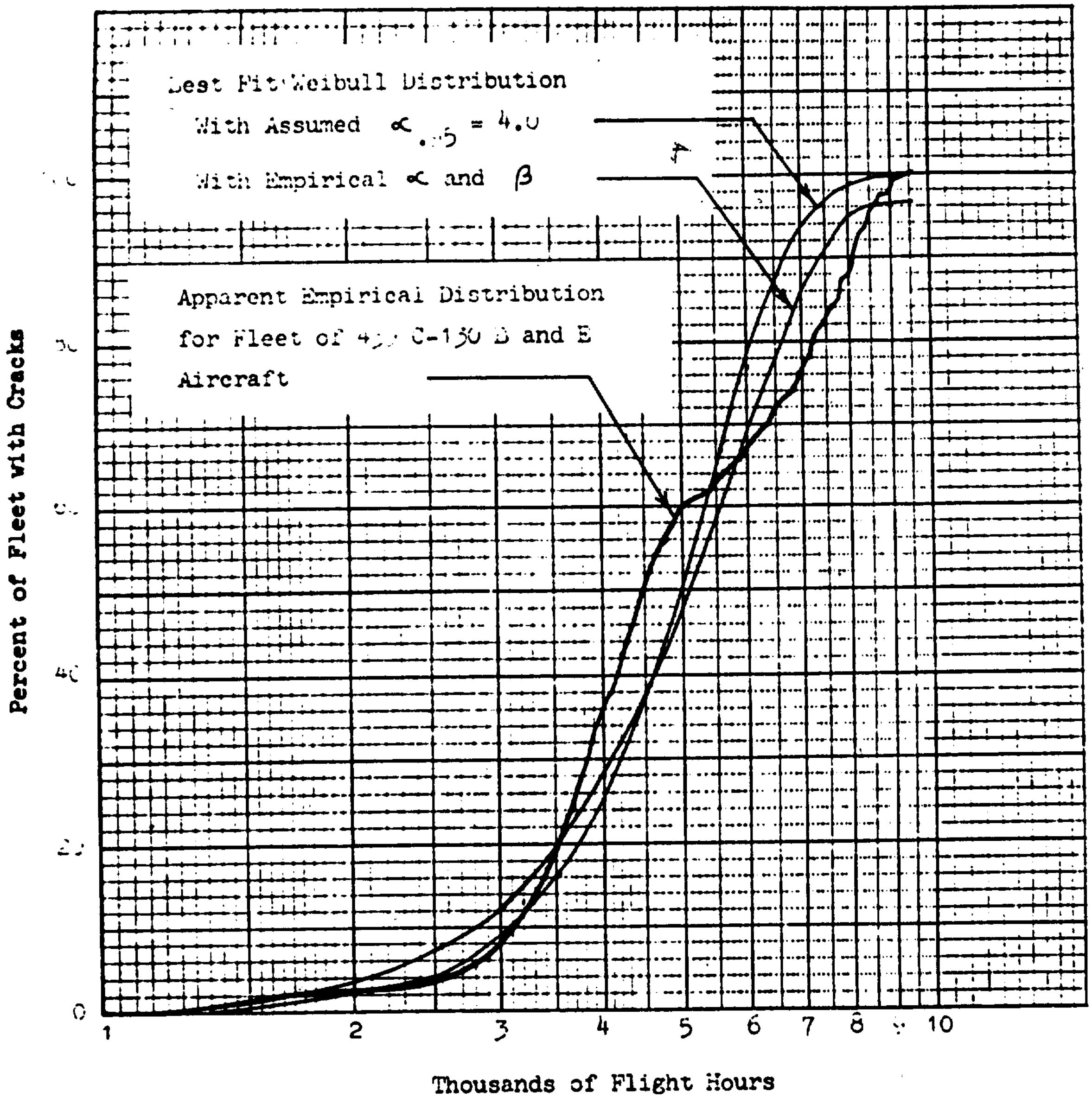


FIGURE 11 APPARENT AND BEST FIT WEIBULL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING LOWER SURFACE STATION 121 FOR WHOLE FLEET

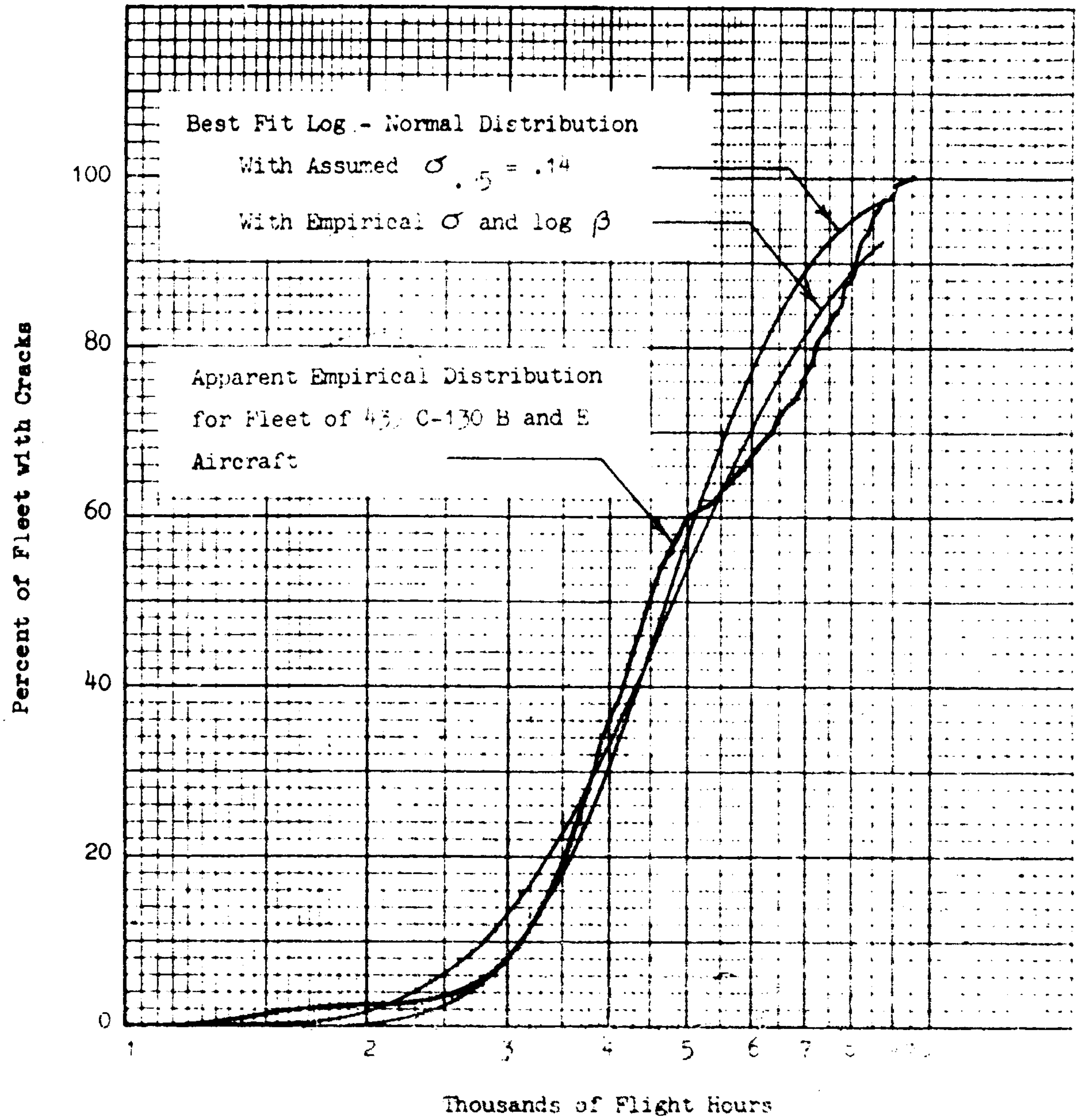


FIGURE 12 APPARENT AND BEST FIT LOG-NORMAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING LOWER SURFACE STATION 121 FOR WHOLE FLEET

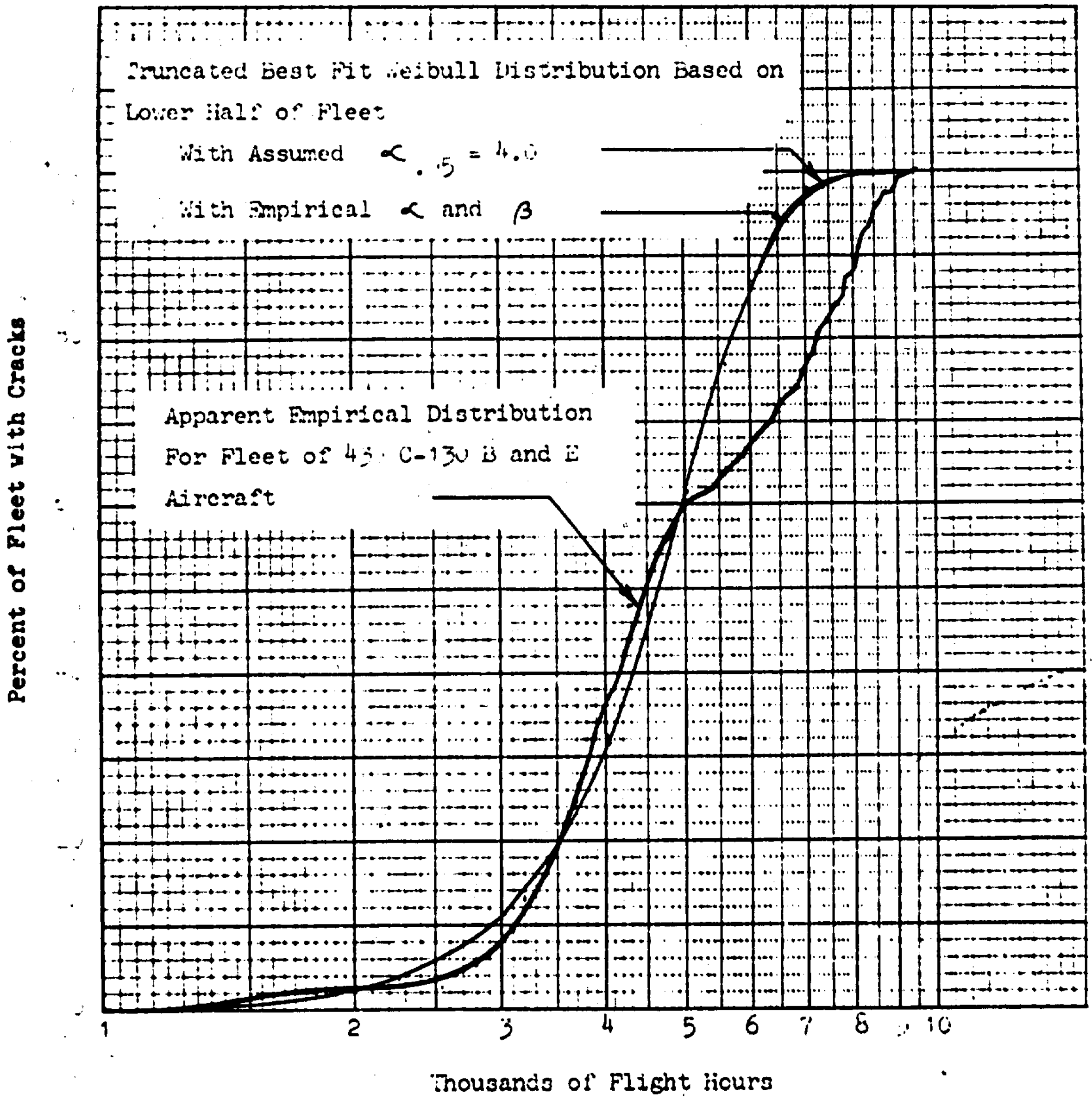


FIGURE 13 APPARENT AND TRUNCATED BEST FIT WEIBULL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING LOWER SURFACE STATION 121 FOR WHOLE FLEET

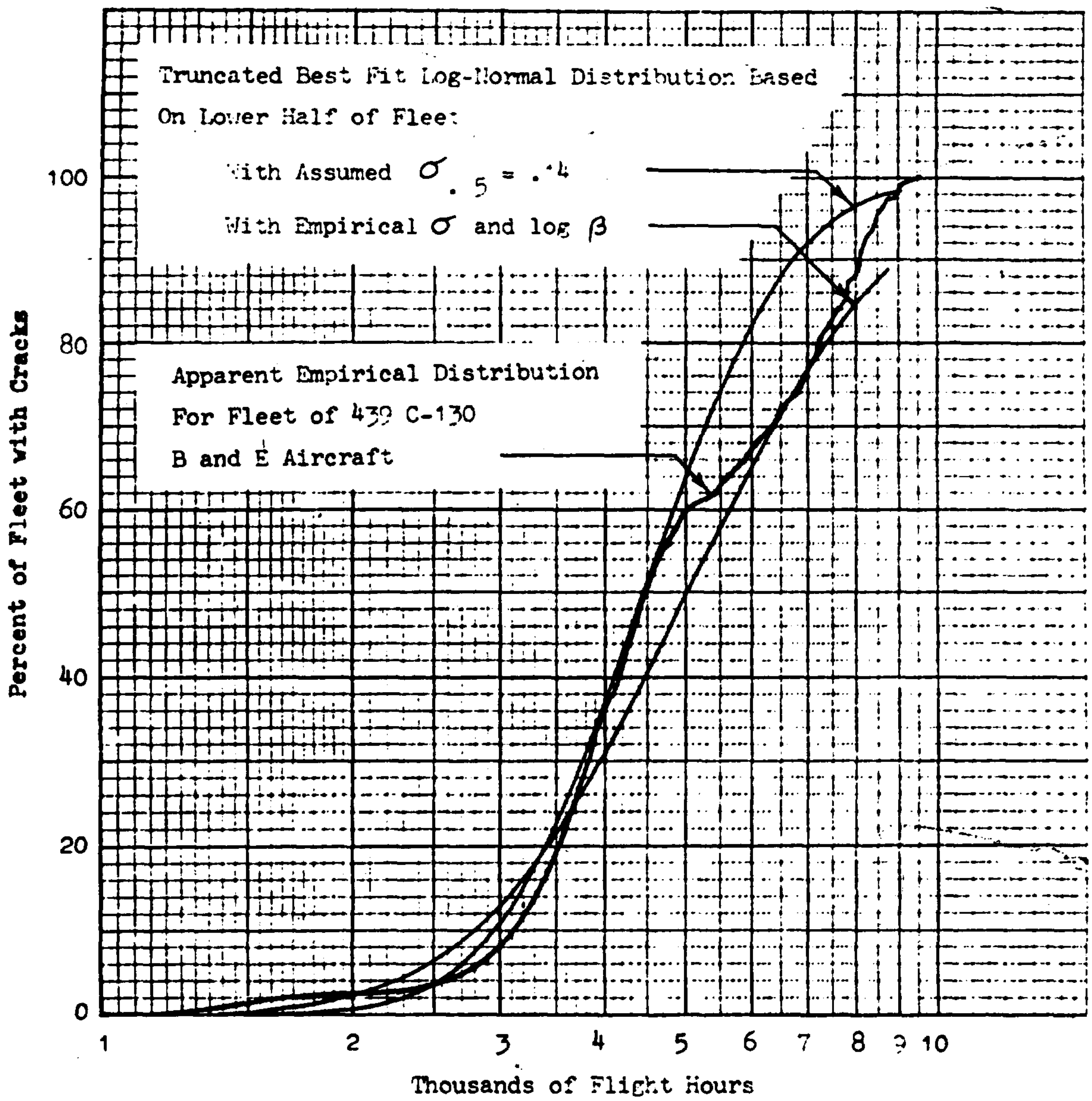


FIGURE 14 APPARENT AND TRUNCATED BEST FIT LOG-NORMAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING LOWER SURFACE STATION 121 FOR WHOLE FLEET

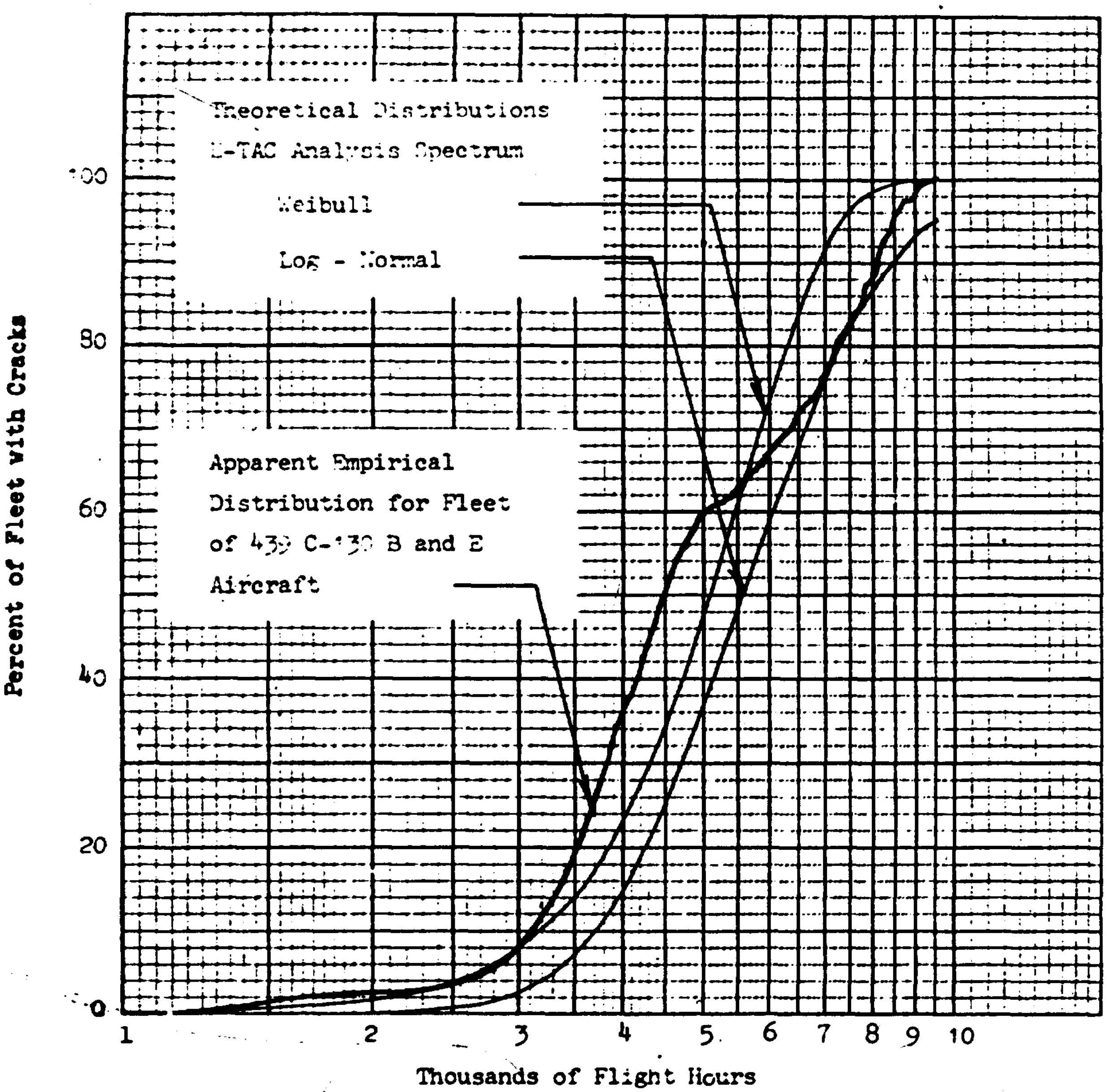


FIGURE 15 APPARENT AND THEORETICAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING LOWER SURFACE STATION 121 FOR WHOLE FLEET

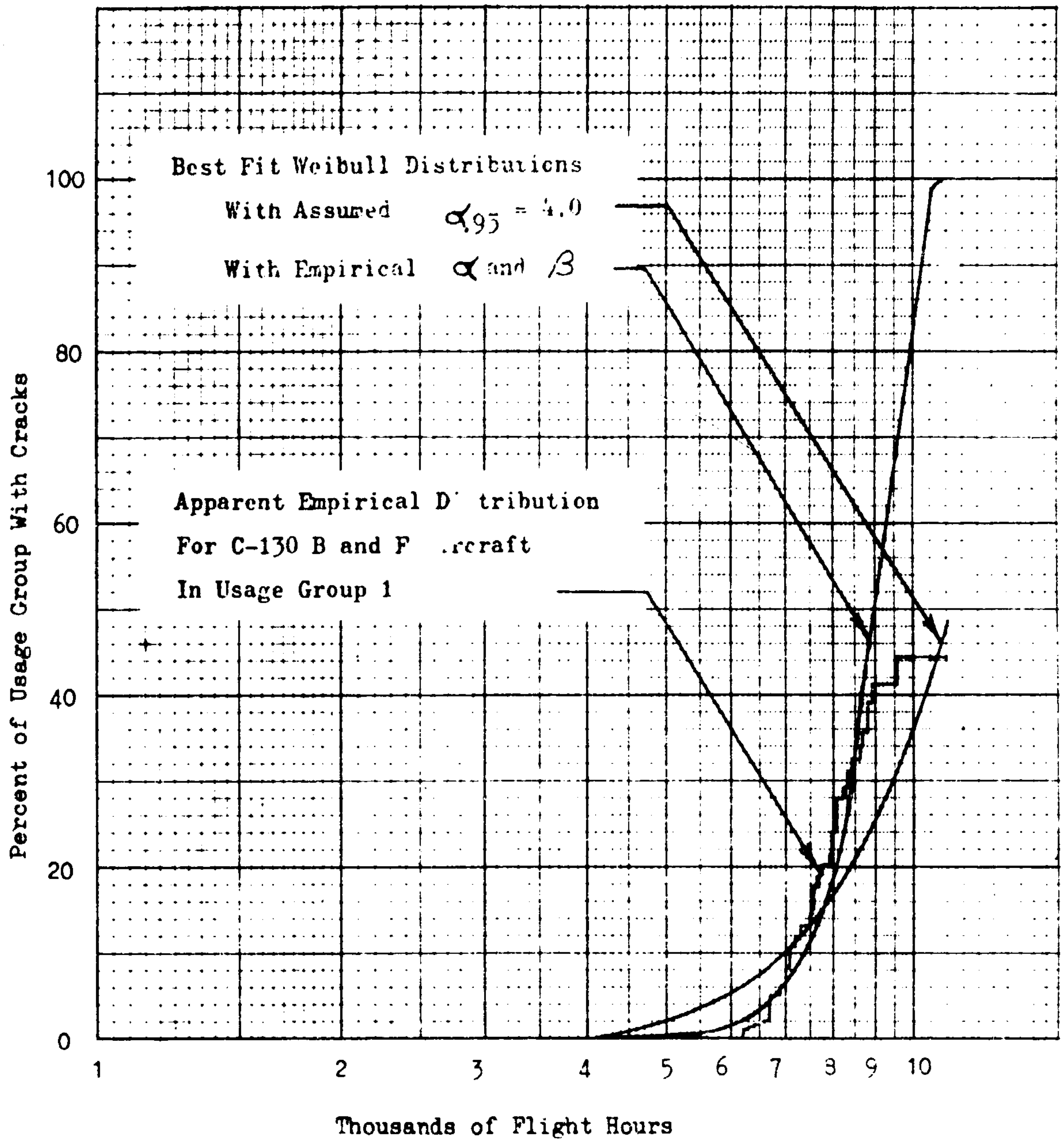


FIGURE 16 APPARENT AND BEST FIT WEIBULL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 38 FOR USAGE GROUP 1

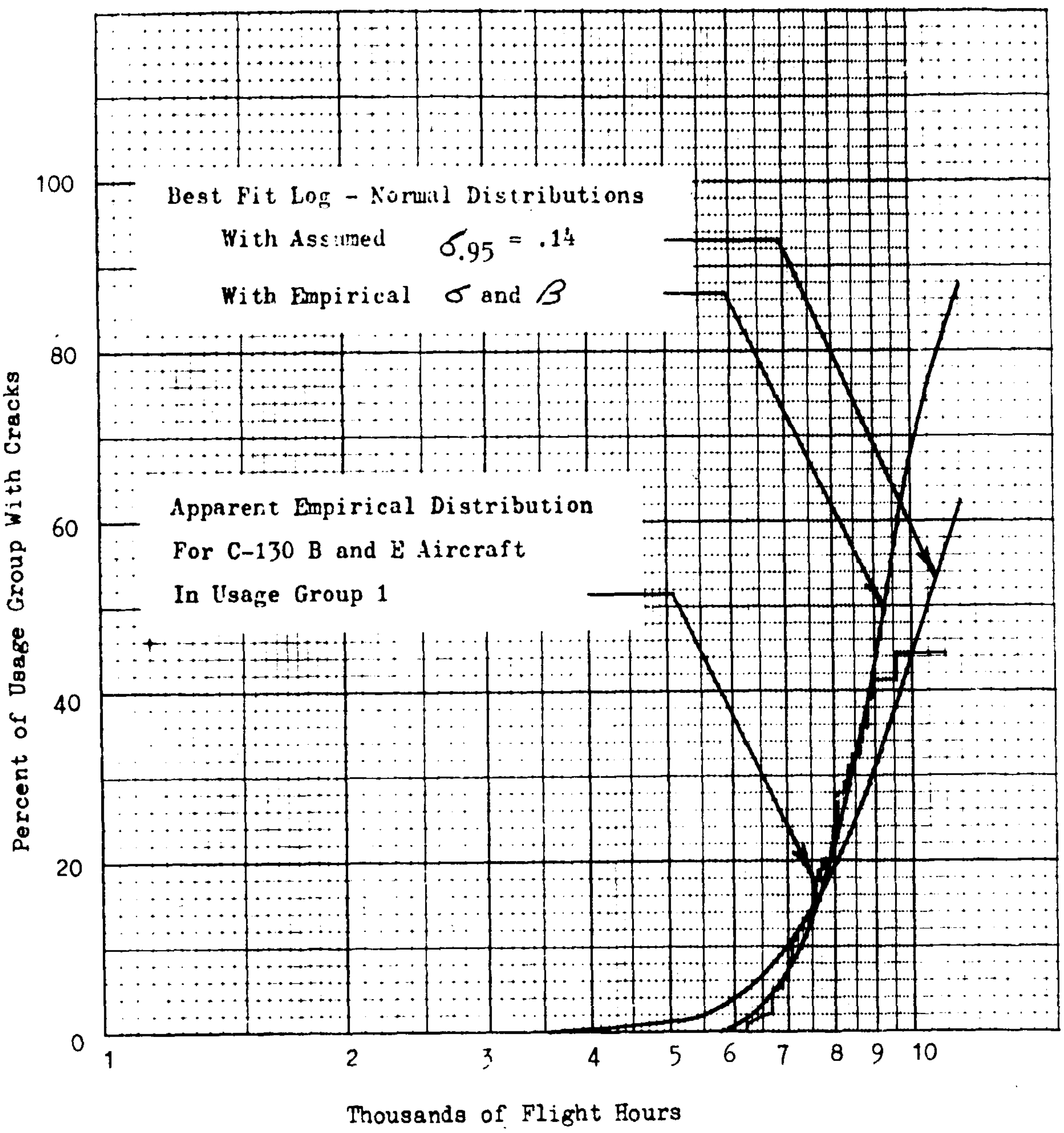


FIGURE 17 APPARENT AND BEST FIT LOG NORMAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 38 FOR USAGE GROUP 1

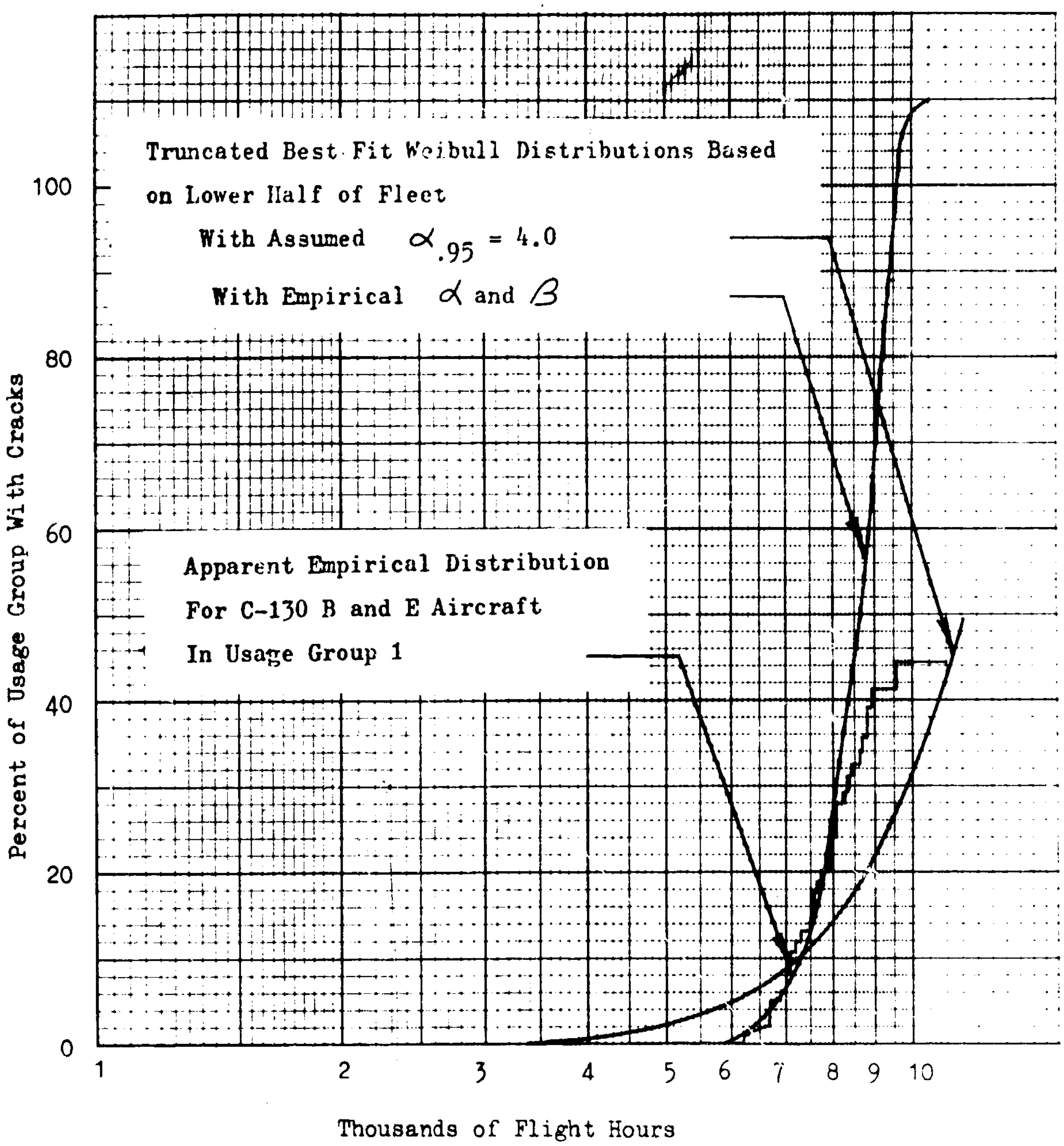


FIGURE 18 APPARENT AND TRUNCATED BEST FIT WEIBULL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 38 FOR USAGE GROUP 1

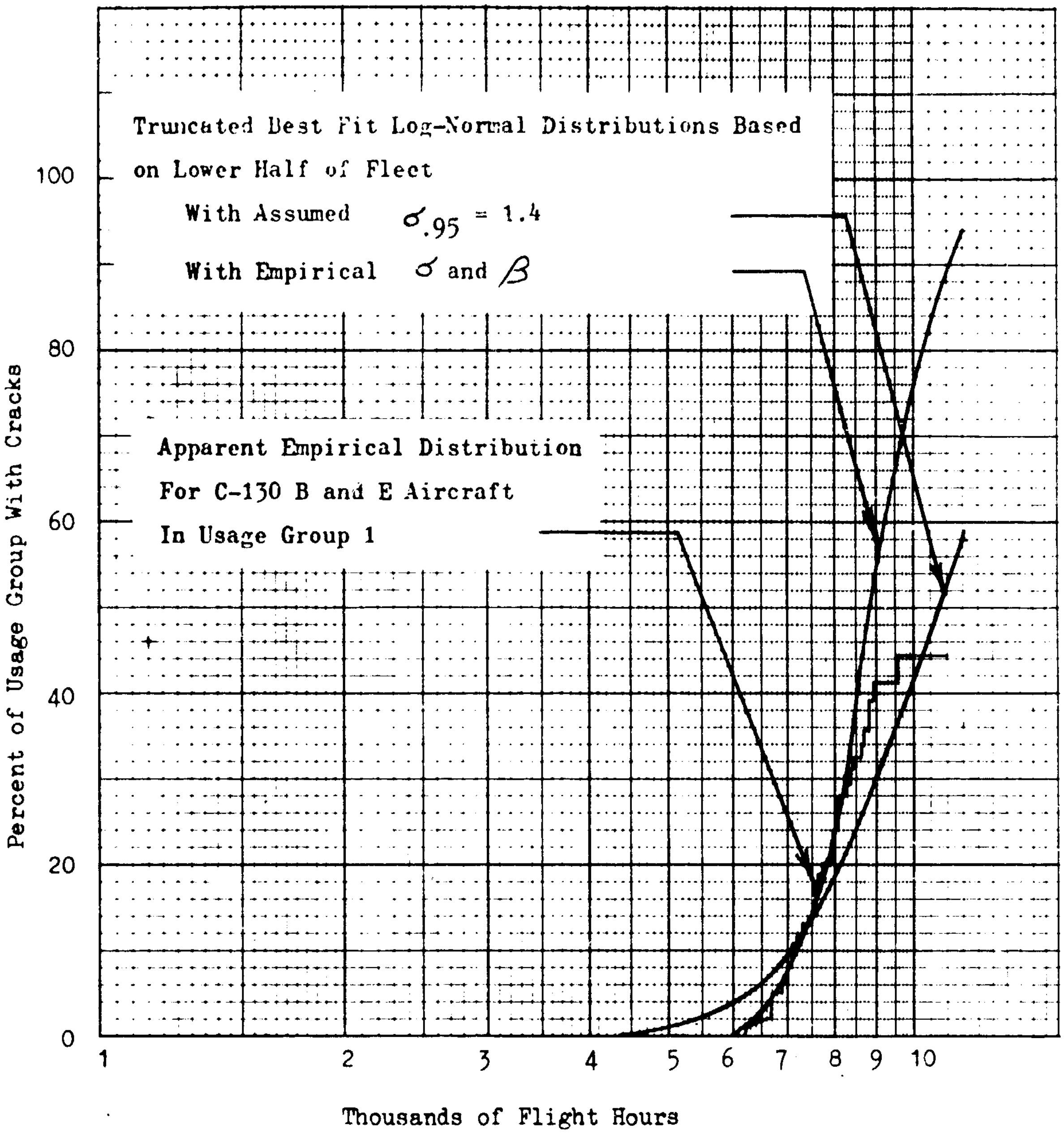


FIGURE 19 APPARENT AND TRUNCATED BEST FIT LOG NORMAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 38 FOR USAGE GROUP 1

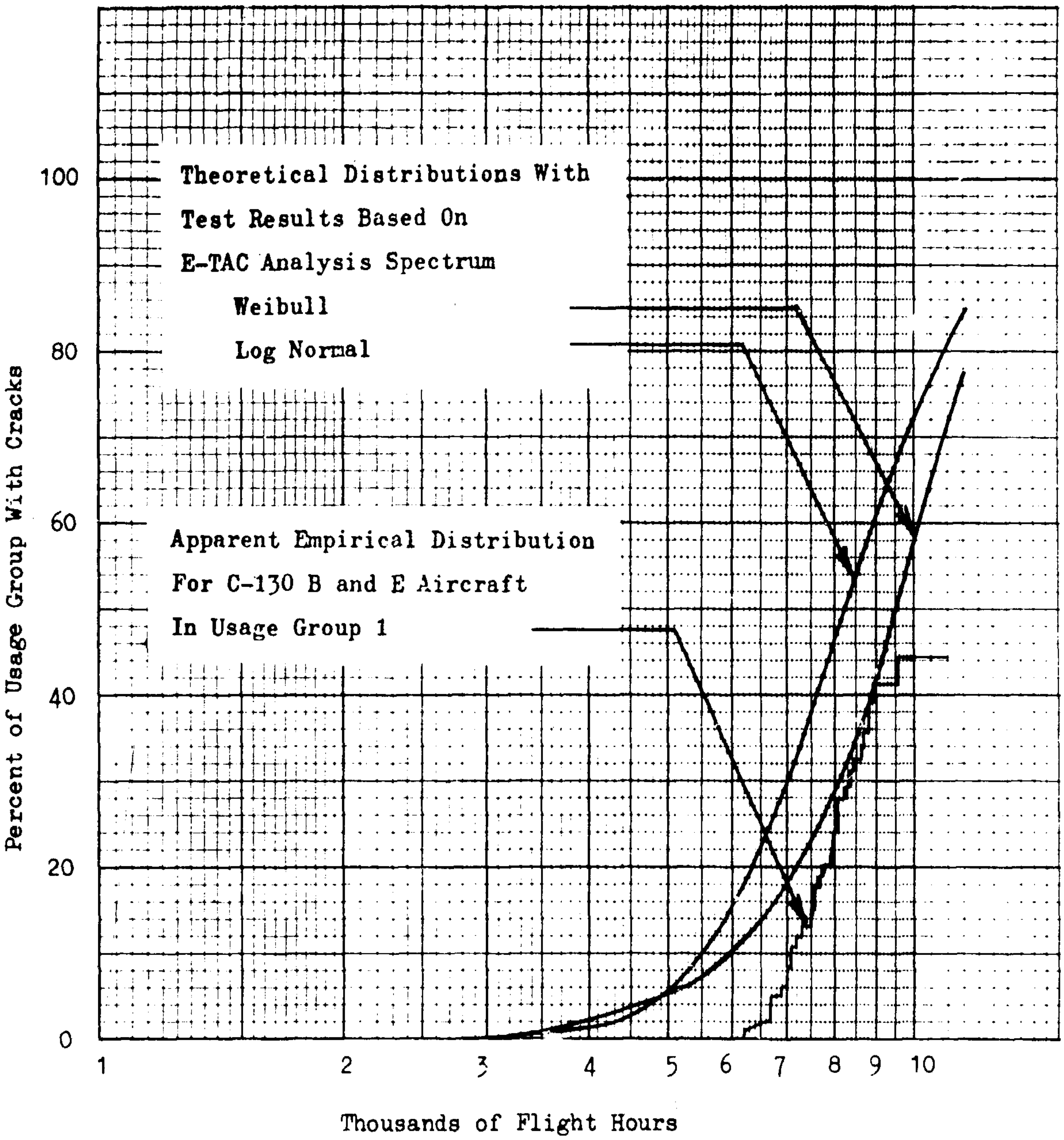


FIGURE 20 APPARENT AND THEORETICAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 38 FOR USAGE GROUP 1

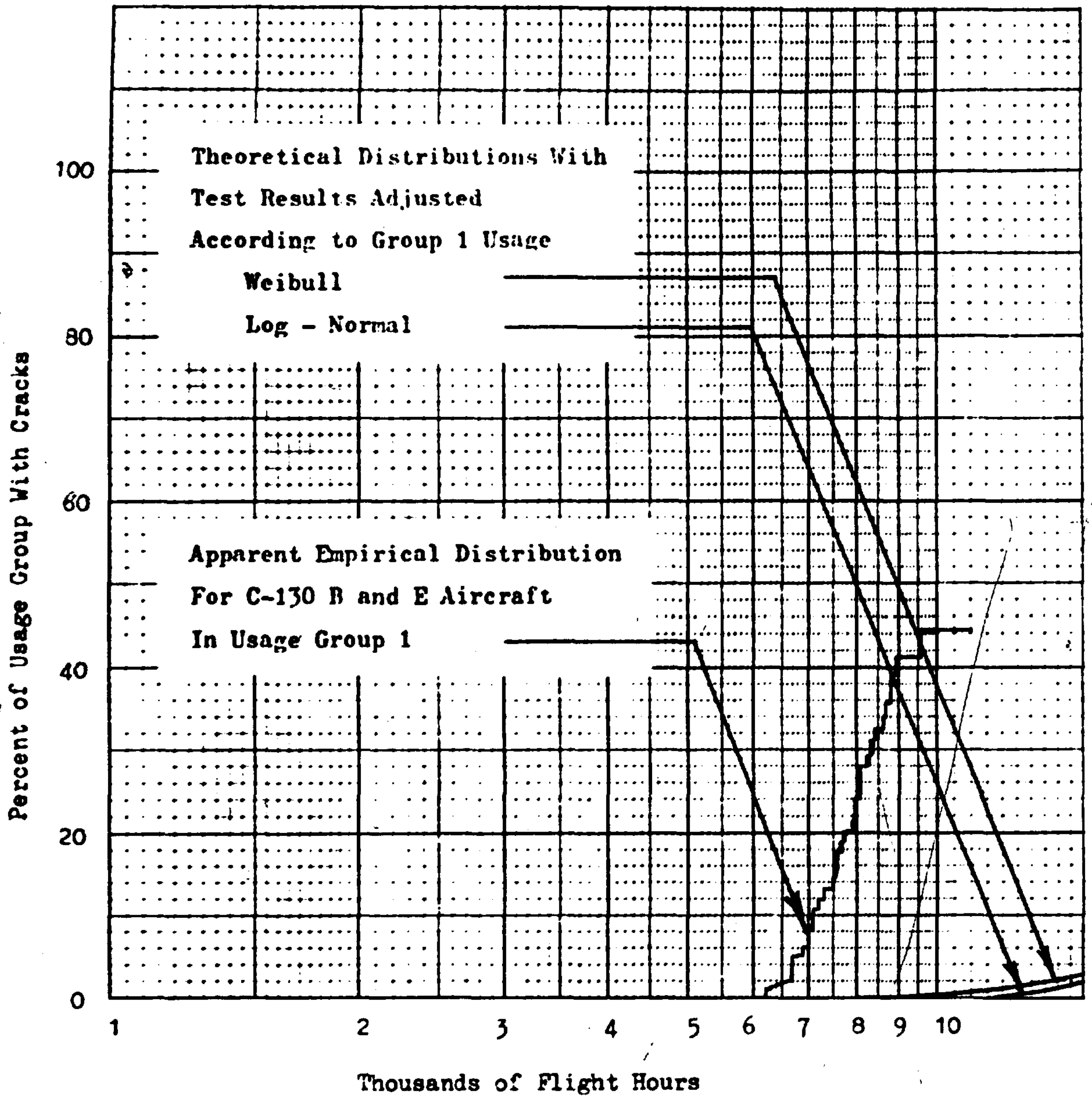


FIGURE 21 THEORETICAL DISTRIBUTION OF PROBABILITY OF TIME TO CRACK INITIATION ADJUSTED FOR GROUP 1 USAGE FOR CENTER WING UPPER SURFACE STATION 38

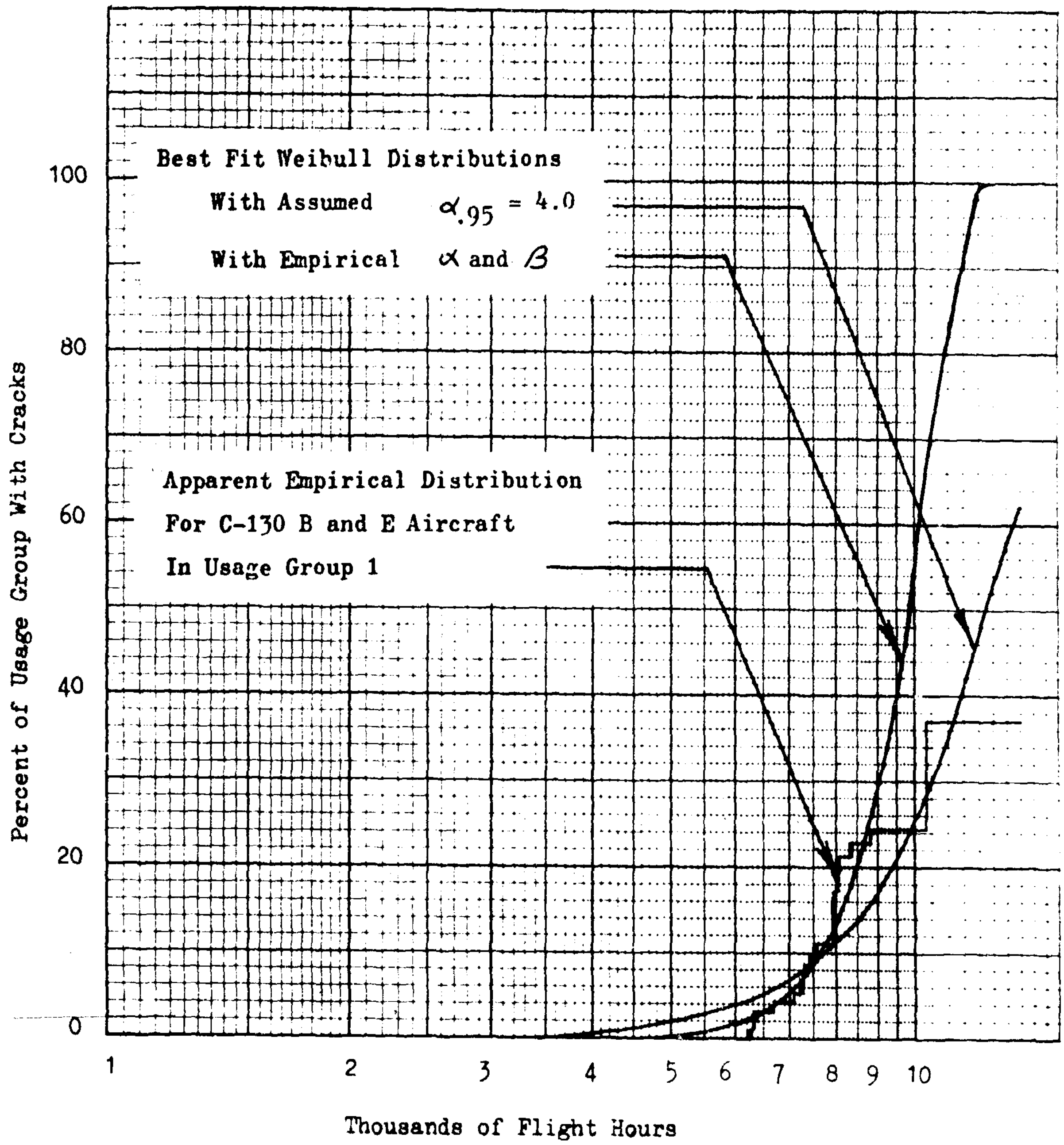


FIGURE 22 APPARENT AND BEST FIT WEIBULL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 105 FOR USAGE GROUP 1

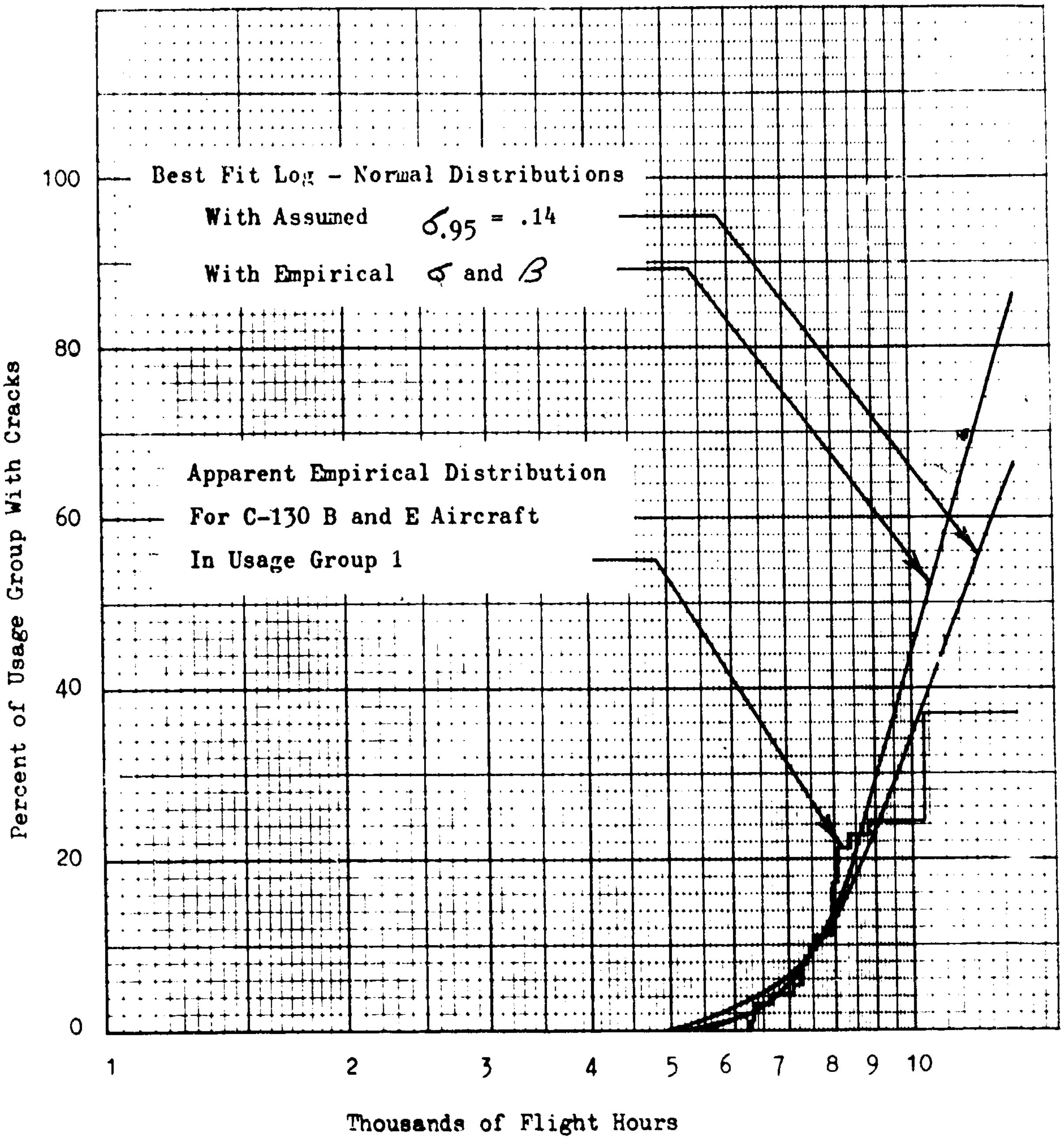


FIGURE 23 APPARENT AND BEST FIT LOG NORMAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 105 FOR USAGE GROUP 1

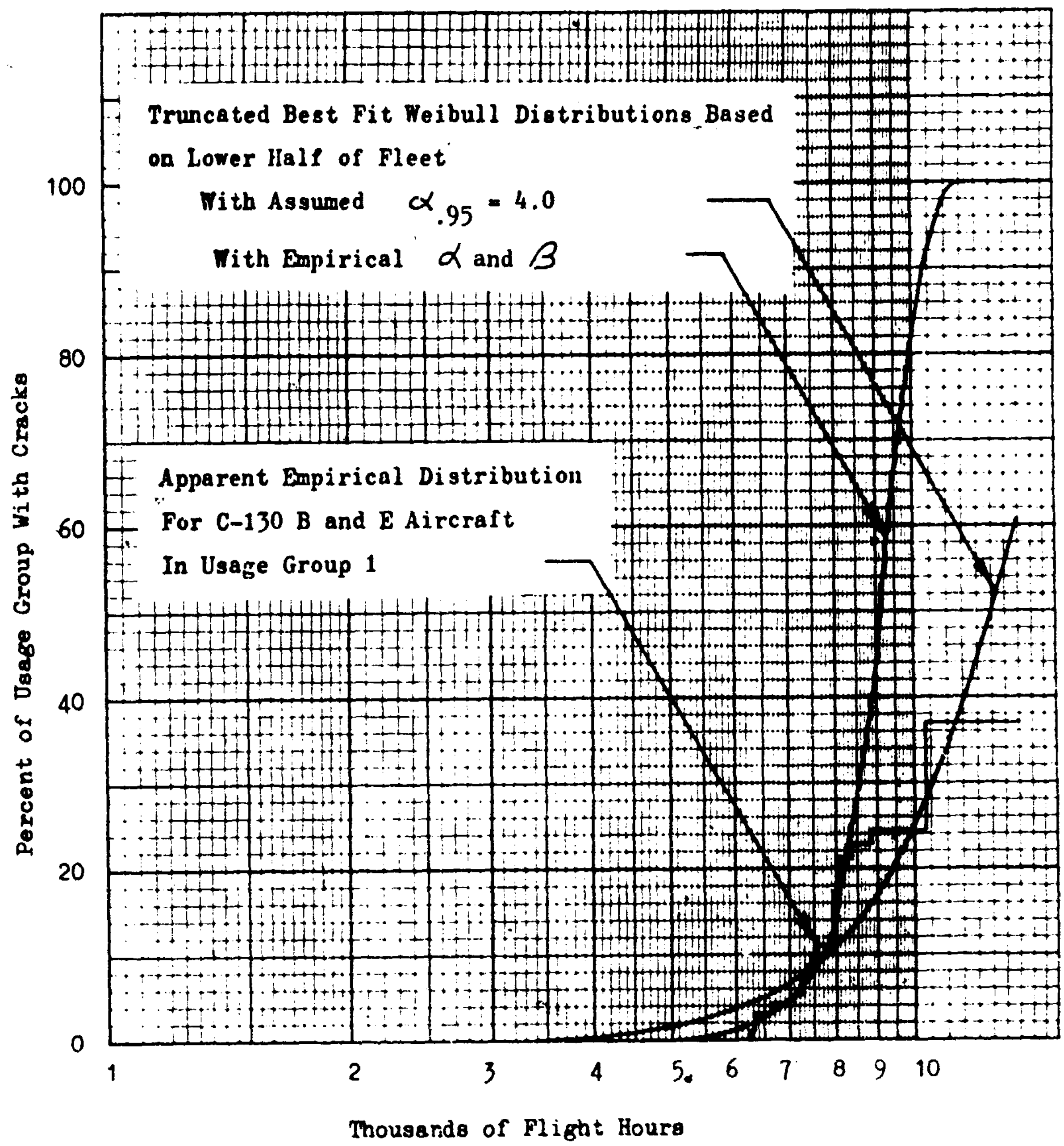


FIGURE 24 APPARENT AND TRUNCATED BEST FIT WEIBULL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 105 FOR USAGE GROUP 1

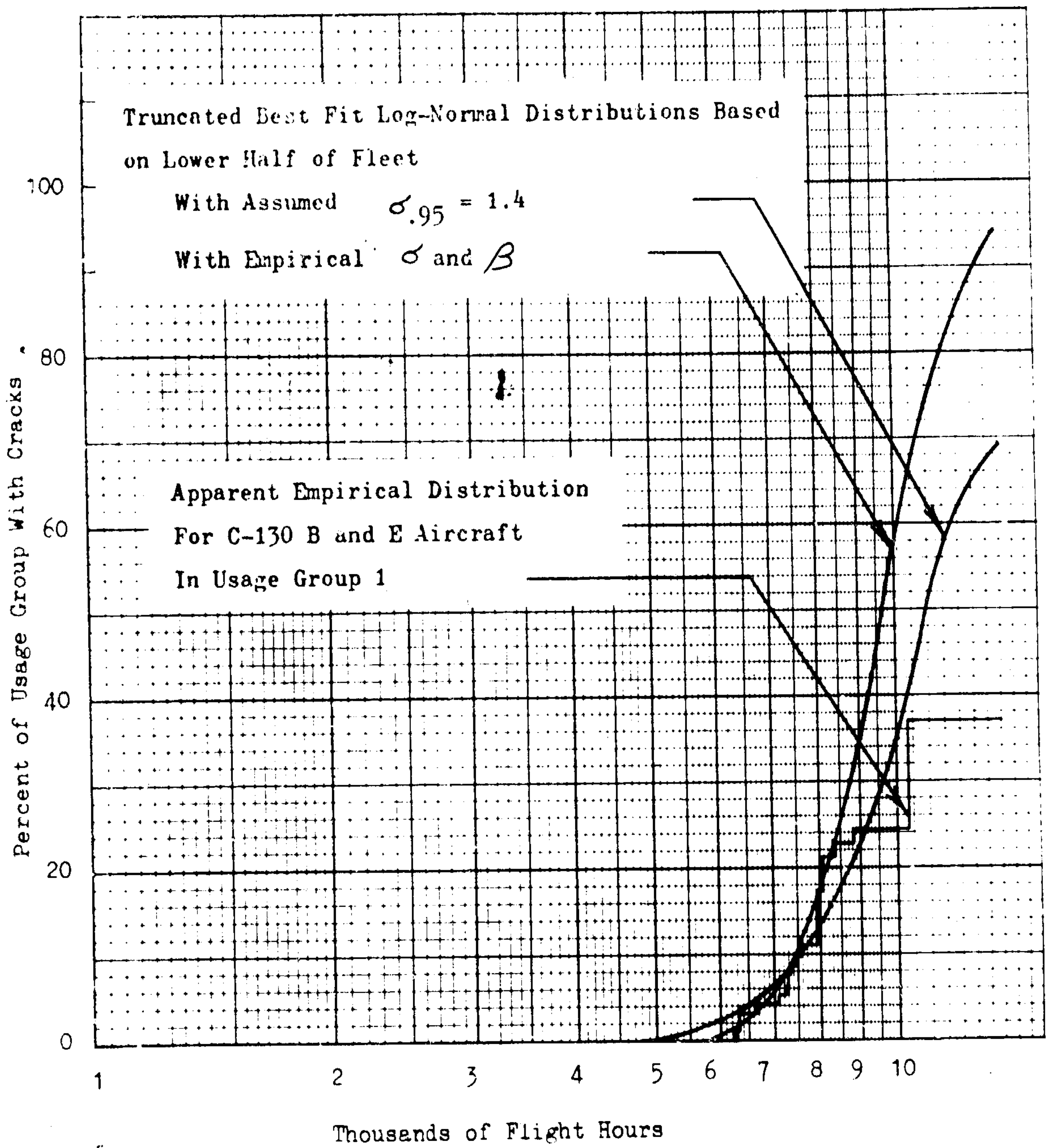


FIGURE 25 APPARENT AND TRUNCATED BEST FIT LOG NORMAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 105 FOR USAGE GROUP 1

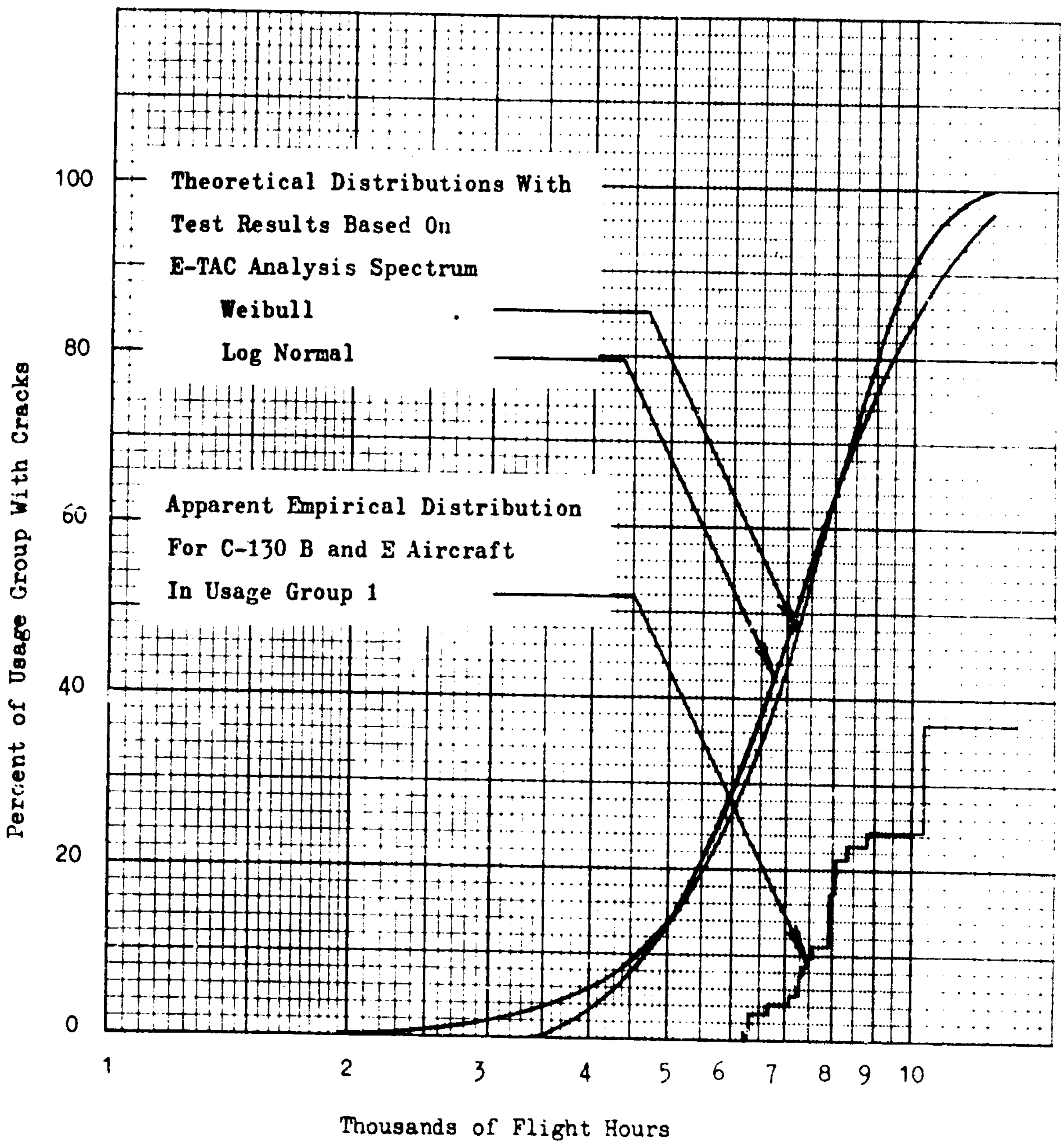


FIGURE 26 APPARENT AND THEORETICAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 105 FOR USAGE GROUP 1

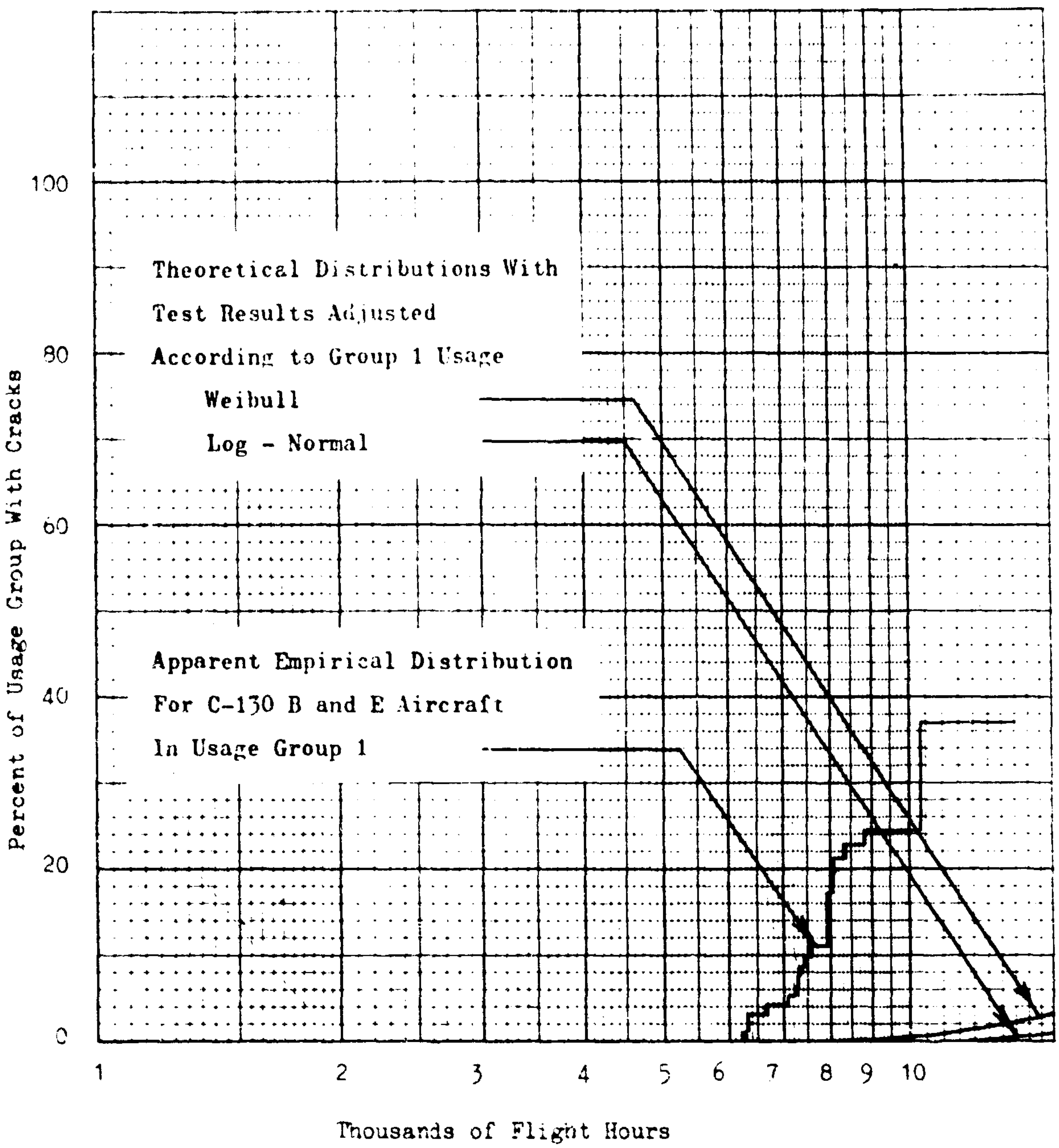


FIGURE 27 THEORETICAL DISTRIBUTION OF PROBABILITY OF TIME TO CRACK INITIATION ADJUSTED FOR GROUP 1 USAGE FOR CENTER WING UPPER SURFACE STATION 105

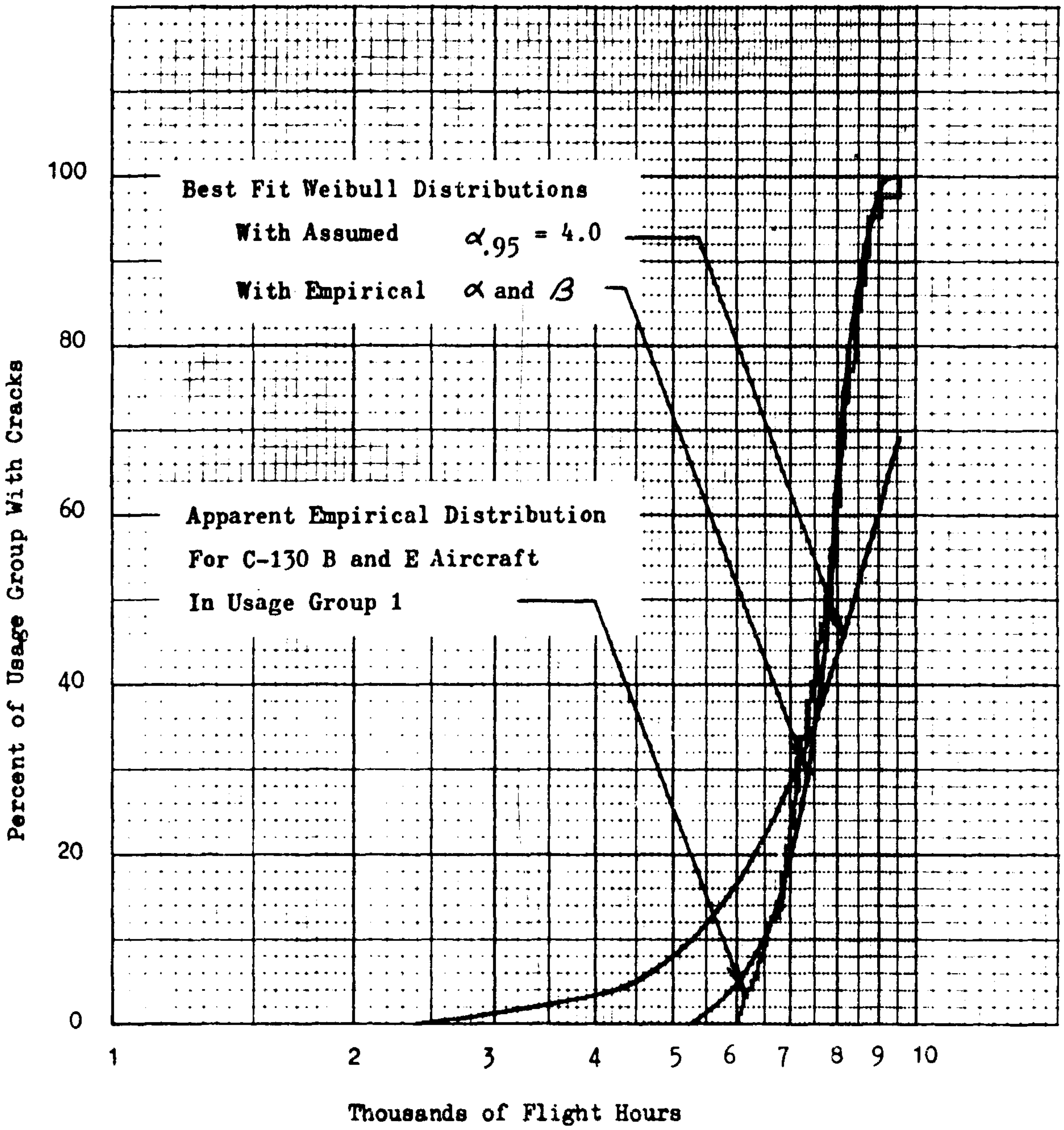


FIGURE 28 APPARENT AND BEST FIT WEIBULL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING LOWER SURFACE STATION 121 FOR USAGE GROUP 1

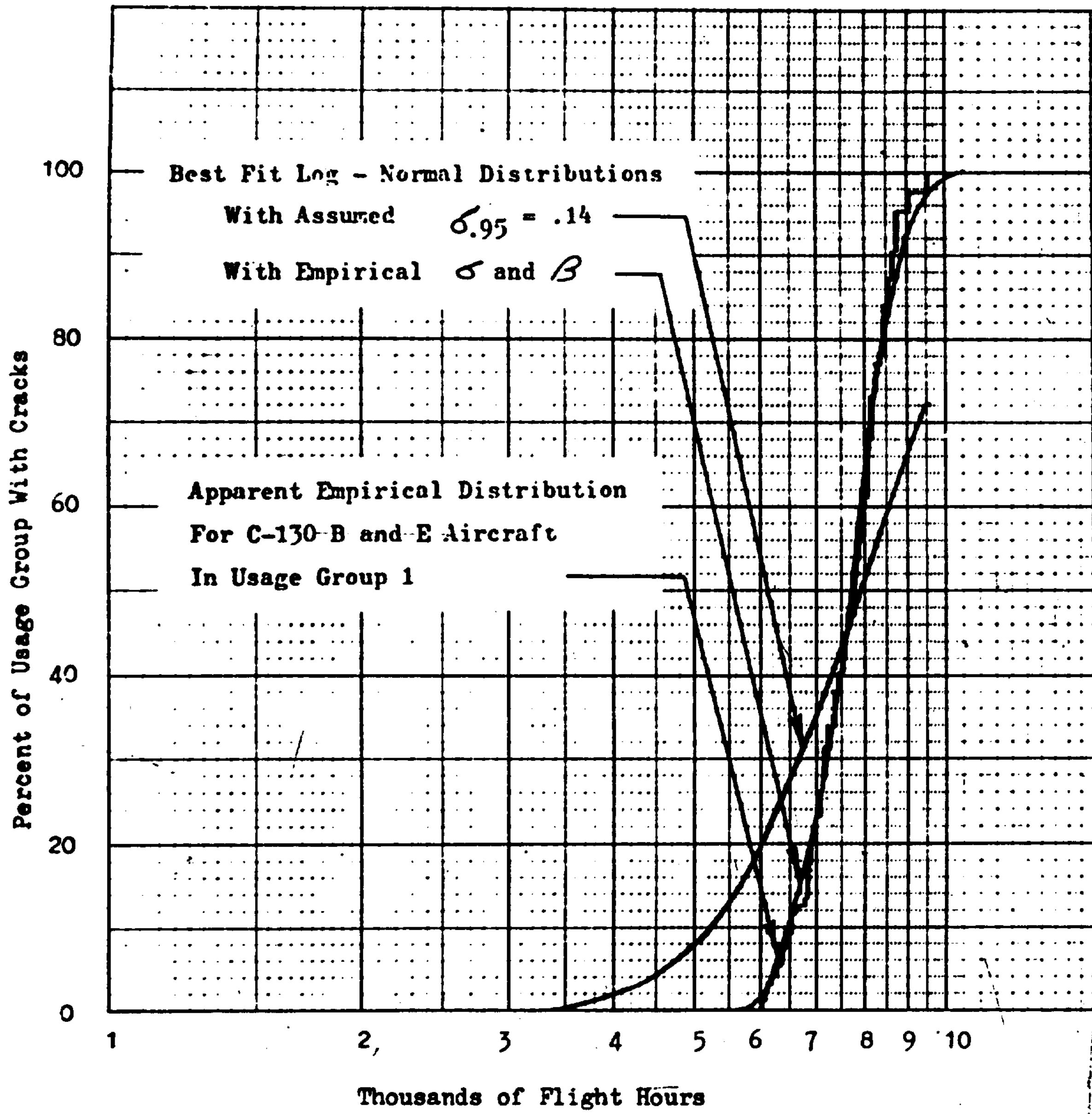


FIGURE 29 APPARENT AND BEST FIT LOG NORMAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING LOWER SURFACE STATION 121 FOR USAGE GROUP 1

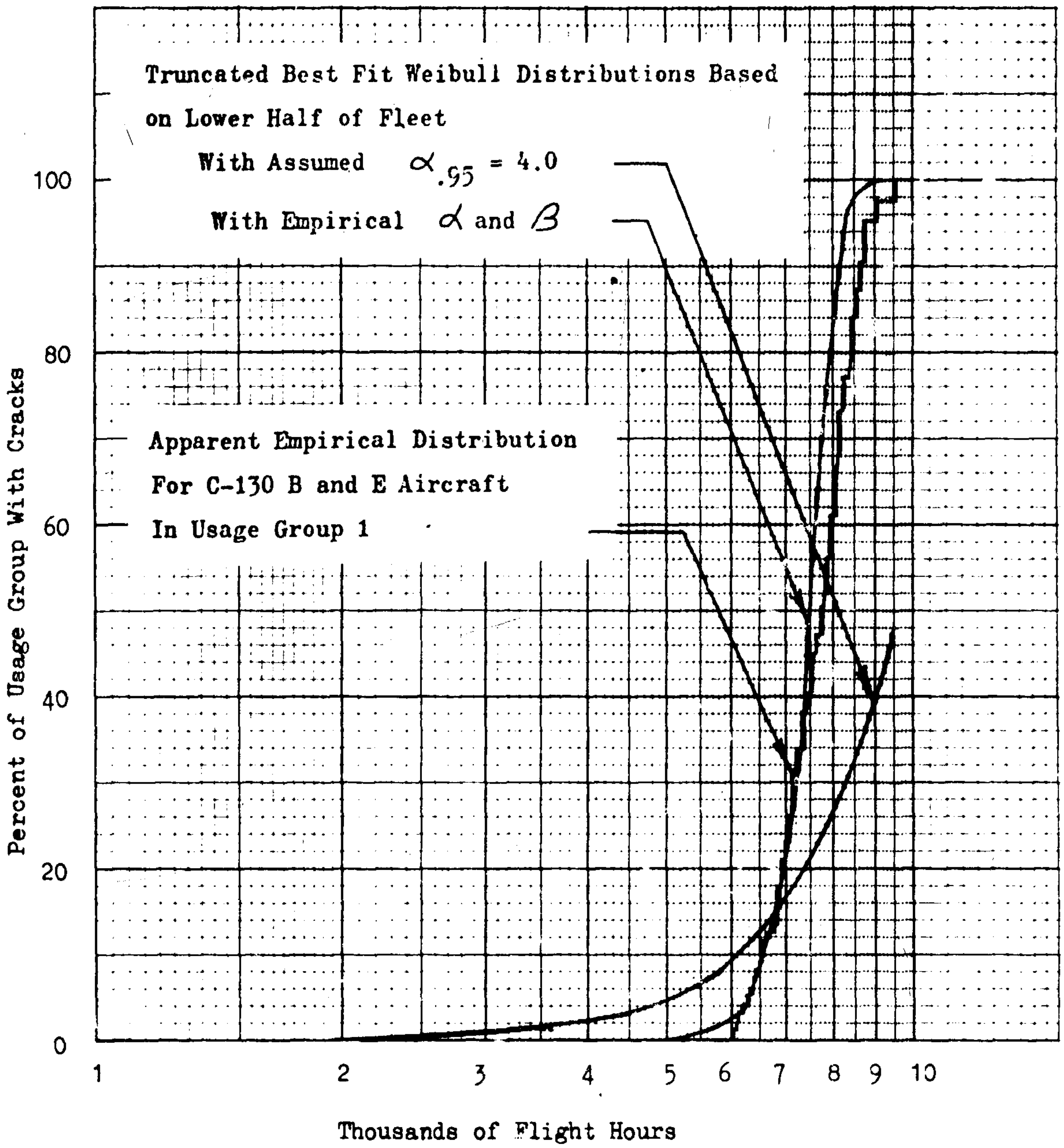


FIGURE 30 APPARENT AND TRUNCATED BEST FIT WEIBULL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING LOWER SURFACE STATION 121 FOR USAGE GROUP 1

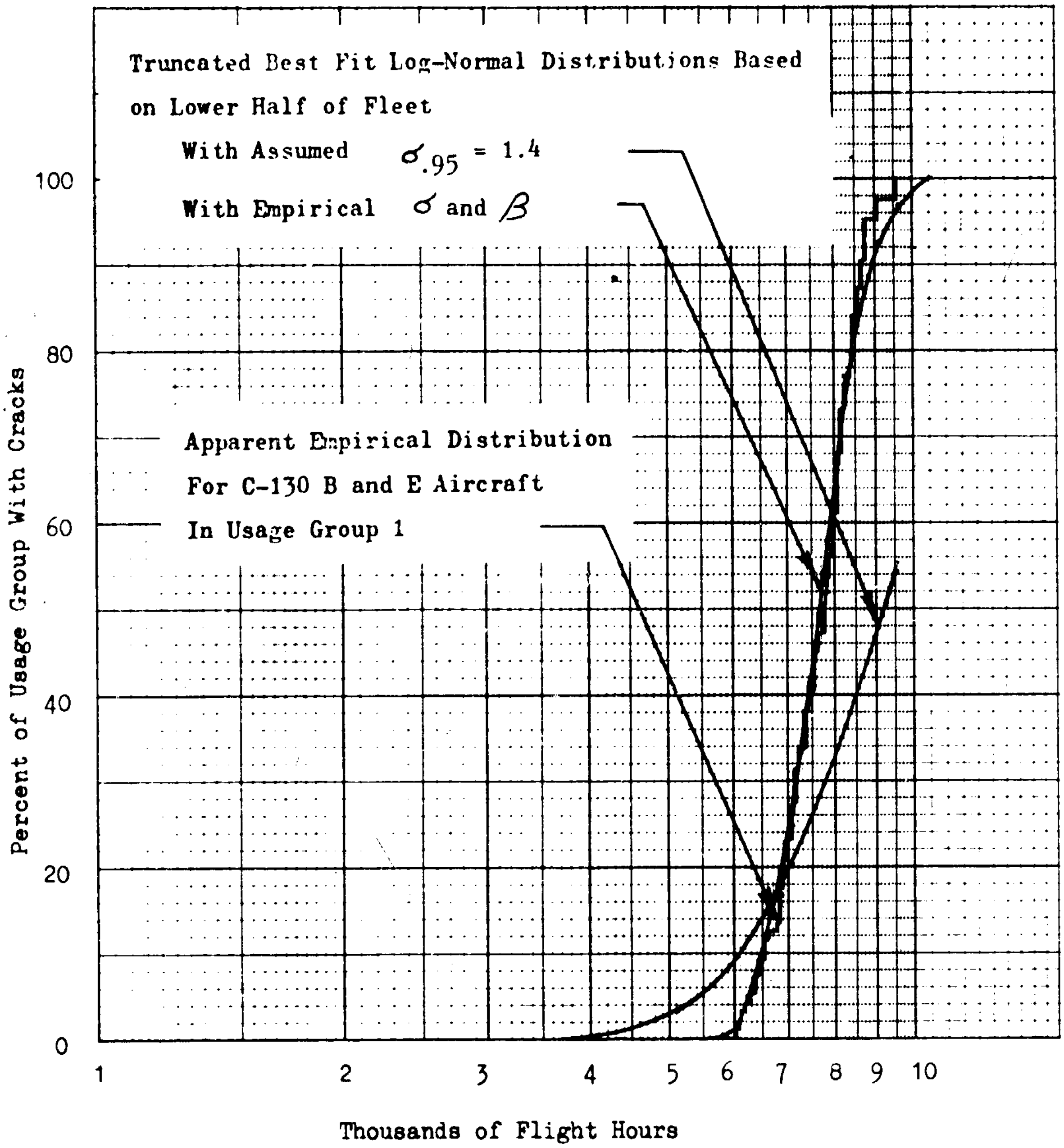


FIGURE 31 APPARENT AND TRUNCATED BEST FIT LOG-NORMAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING LOWER SURFACE STATION 121 FOR USAGE GROUP 1

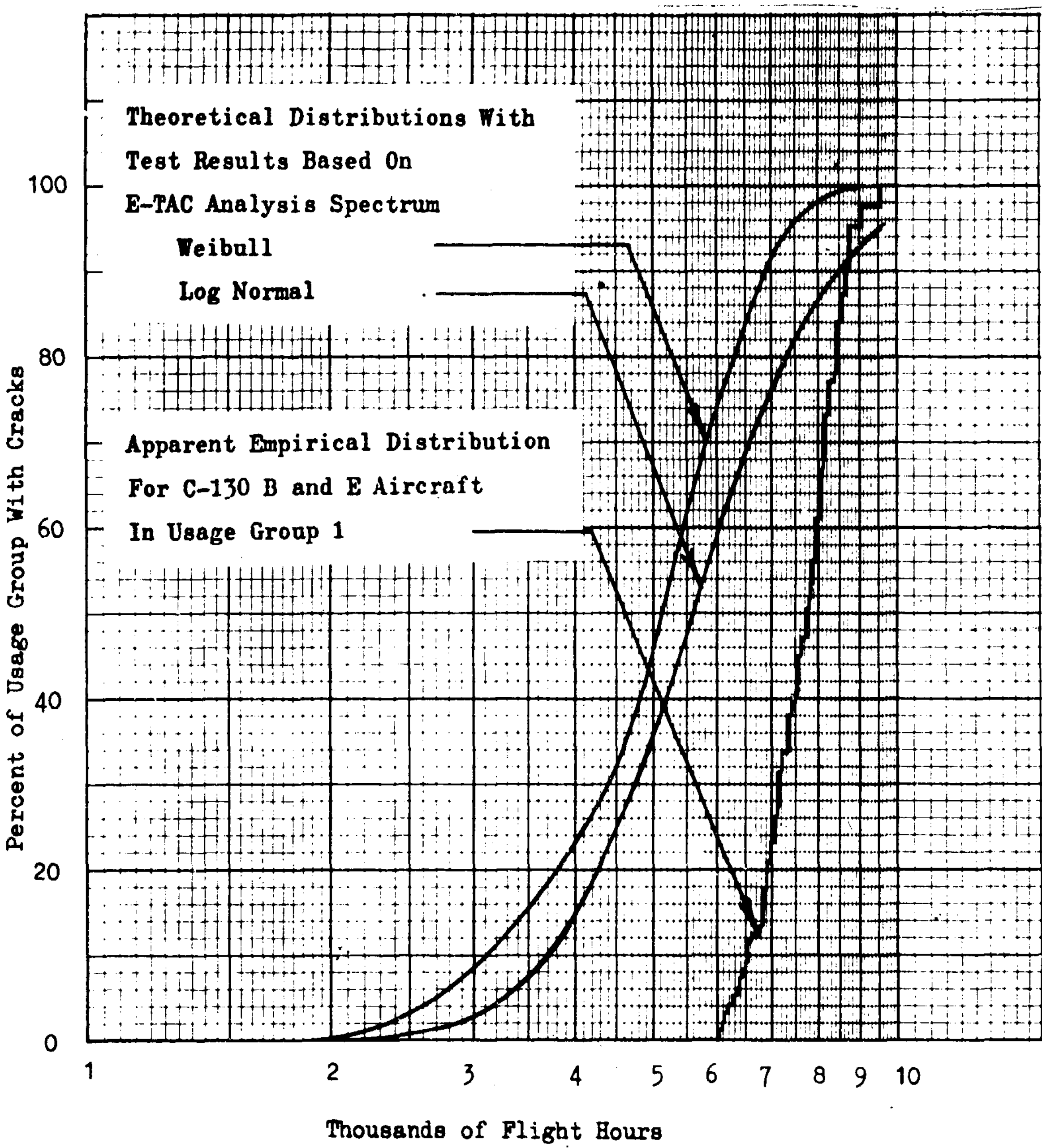


FIGURE 32 APPARENT AND THEORETICAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING LOWER SURFACE STATION 121 FOR USAGE GROUP 1

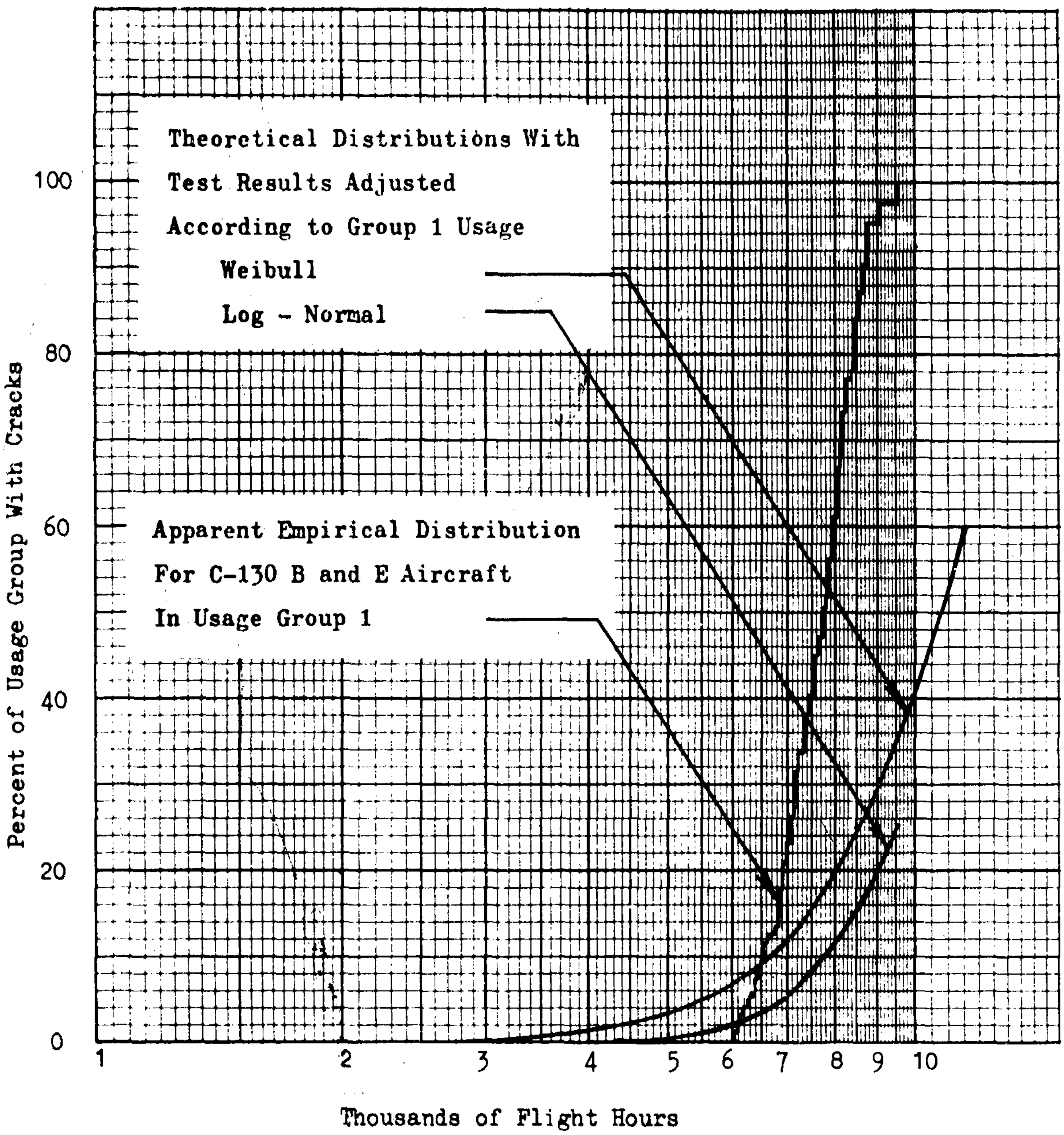


FIGURE 33 THEORETICAL DISTRIBUTION OF PROBABILITY OF TIME TO CRACK INITIATION ADJUSTED FOR GROUP 1 USAGE FOR CENTER WING LOWER SURFACE STATION 121

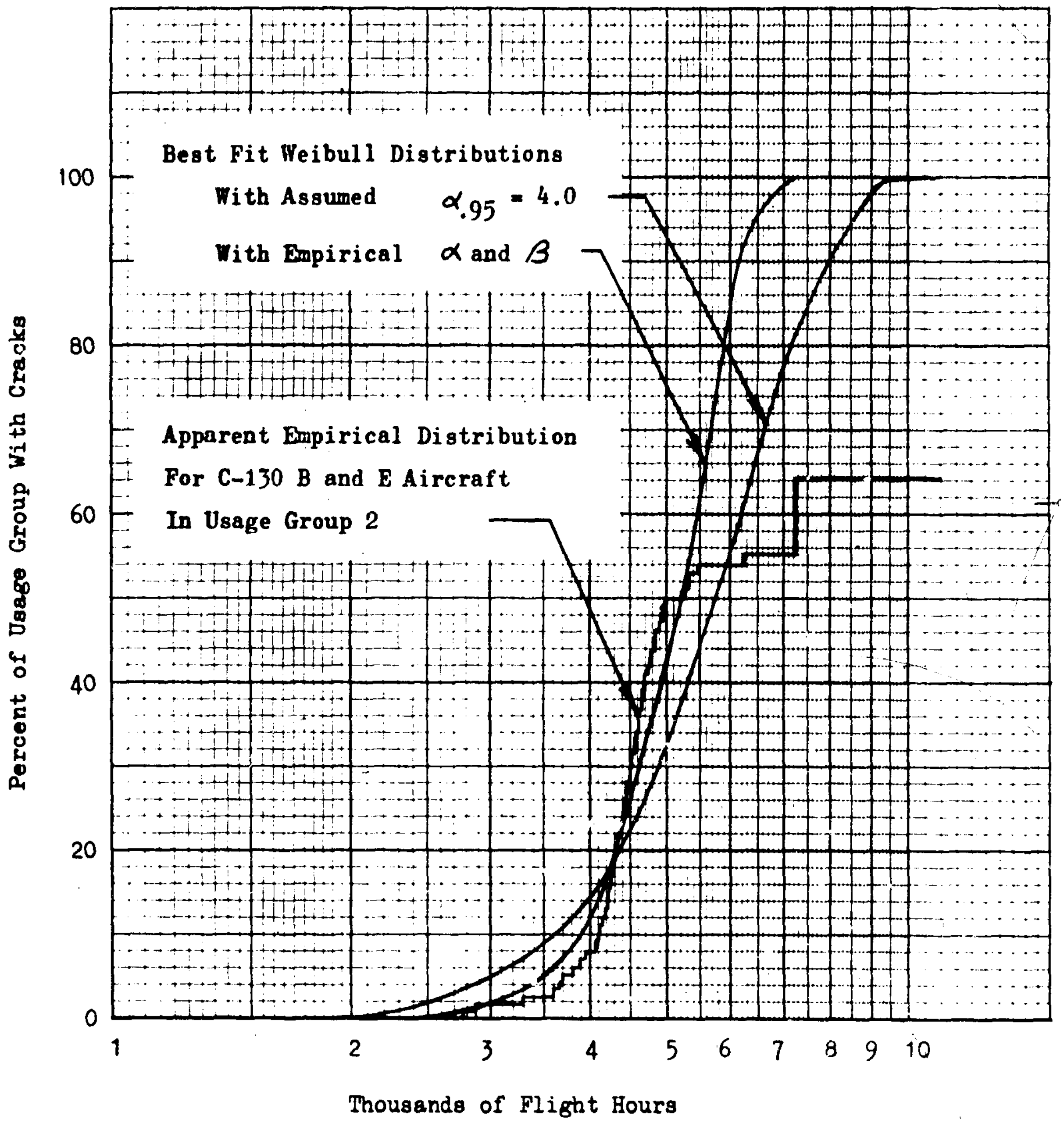


FIGURE 34 APPARENT AND BEST FIT WEIBULL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 38 FOR USAGE GROUP 2

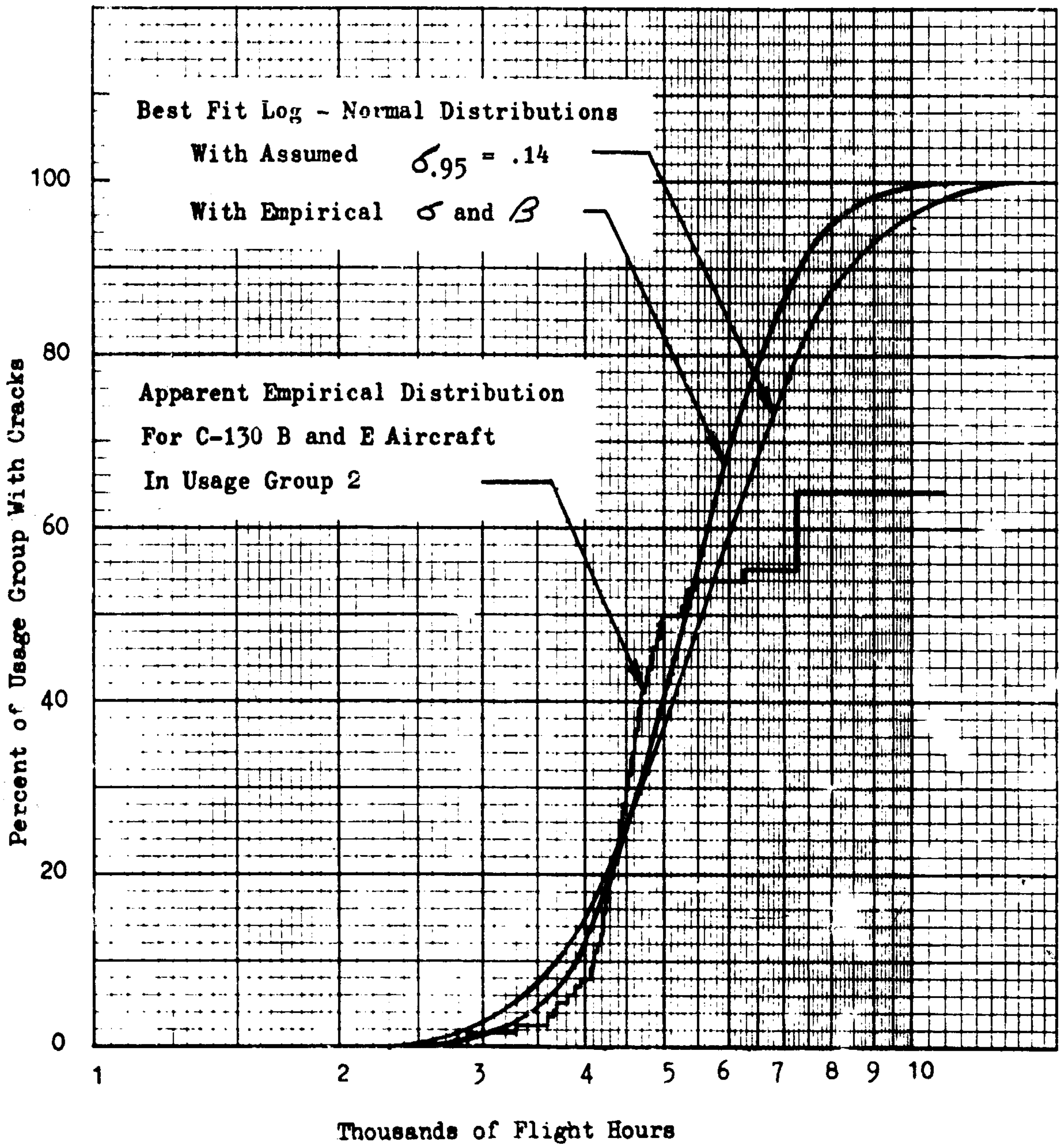


FIGURE 35 APPARENT AND BEST FIT LOG NORMAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 38 FOR USAGE GROUP 2

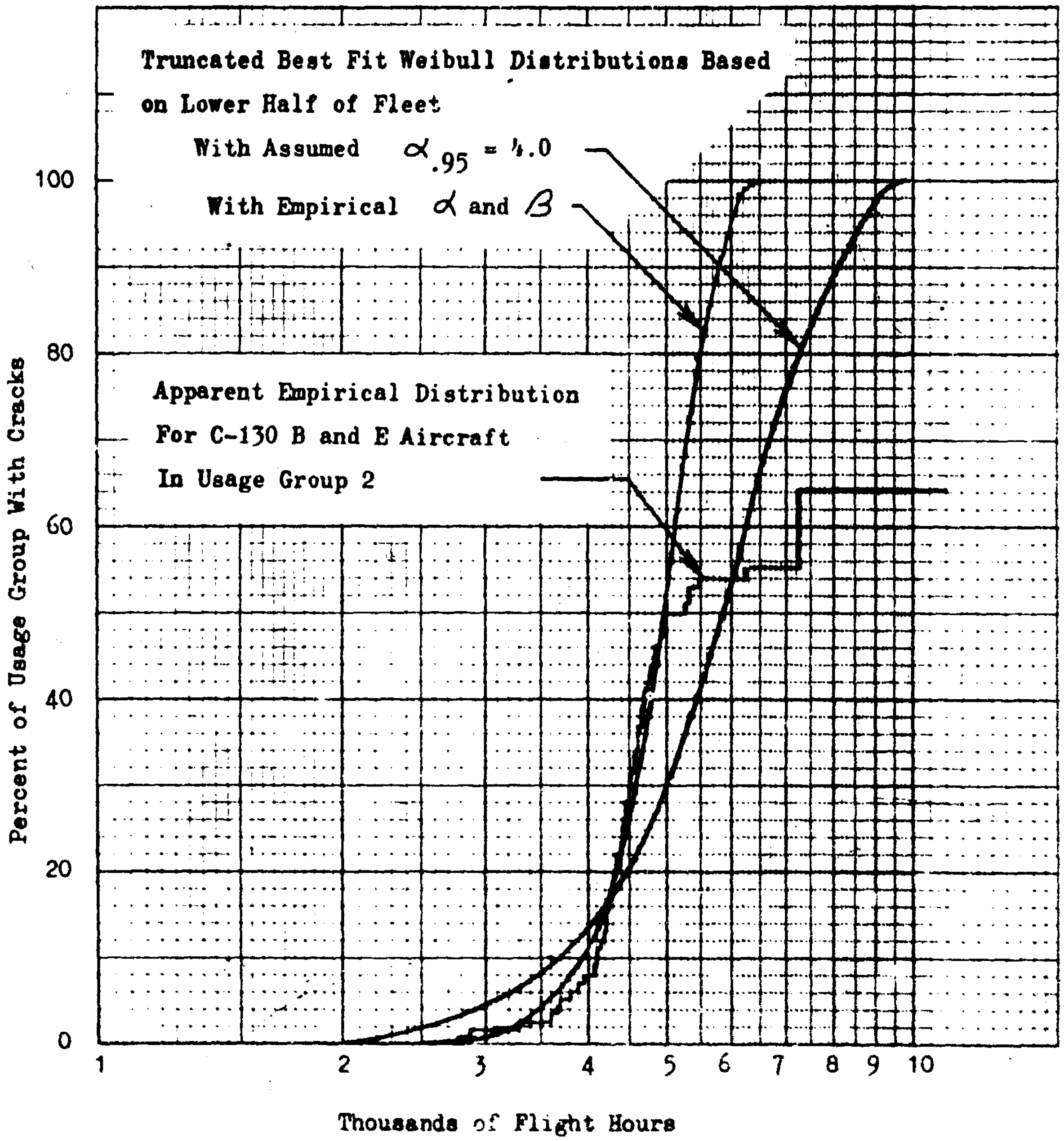


FIGURE 36 APPARENT AND TRUNCATED BEST FIT WEIBULL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 38 FOR USAGE GROUP 2

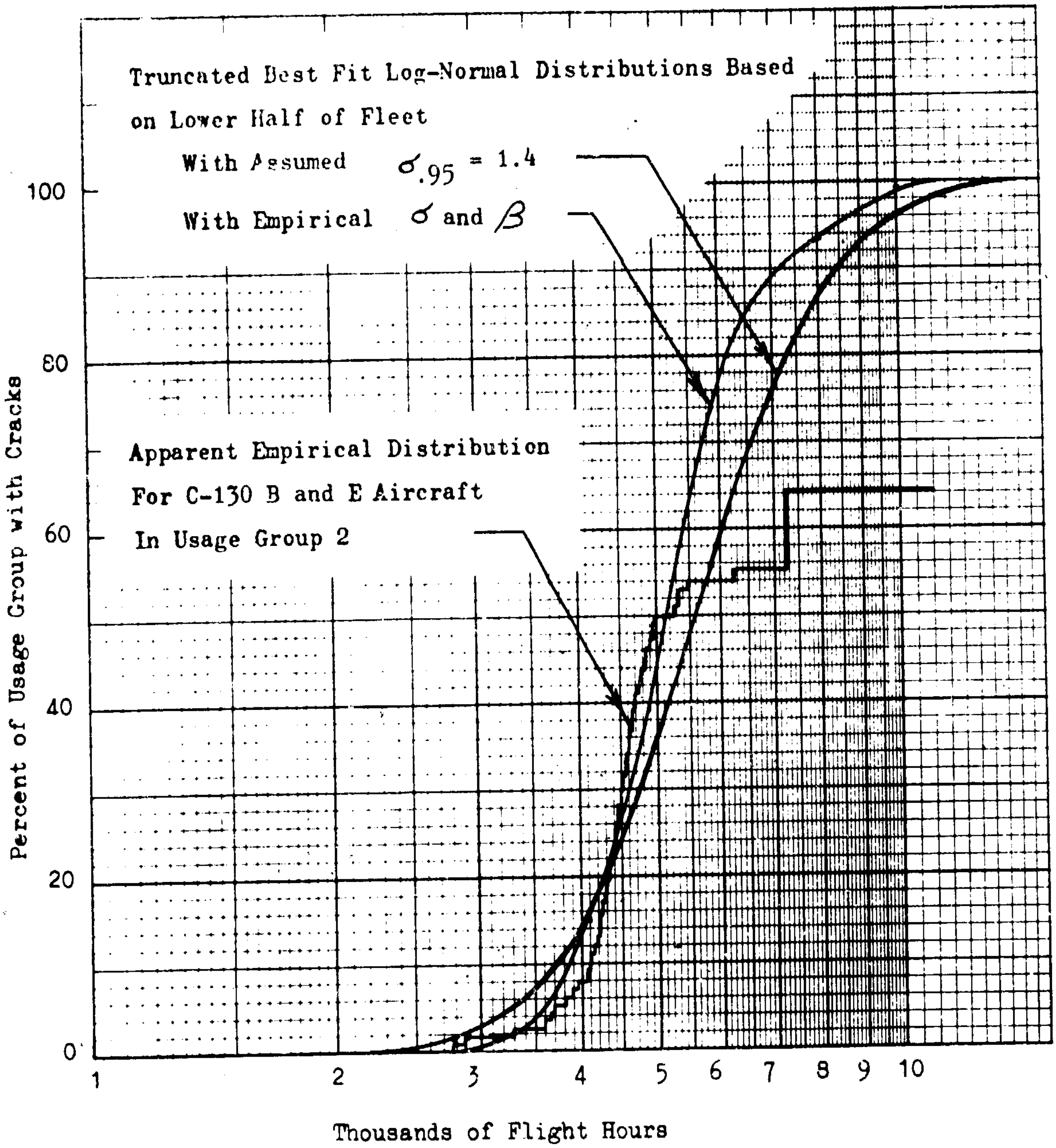


FIGURE 37 APPARENT AND TRUNCATED BEST FIT LOG-NORMAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 38 FOR USAGE GROUP 2

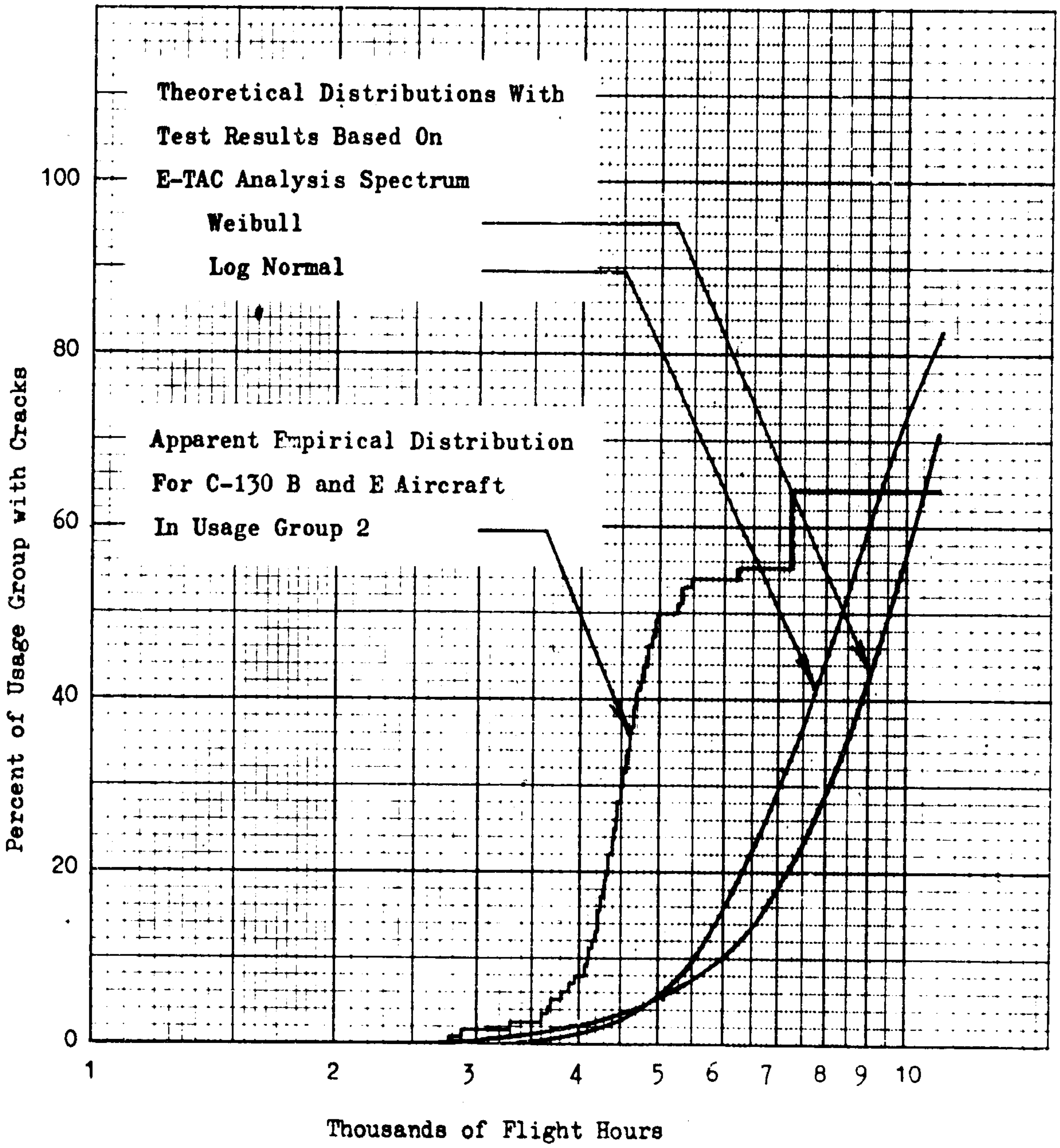


FIGURE 38 APPARENT AND THEORETICAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 38 FOR USAGE GROUP 2

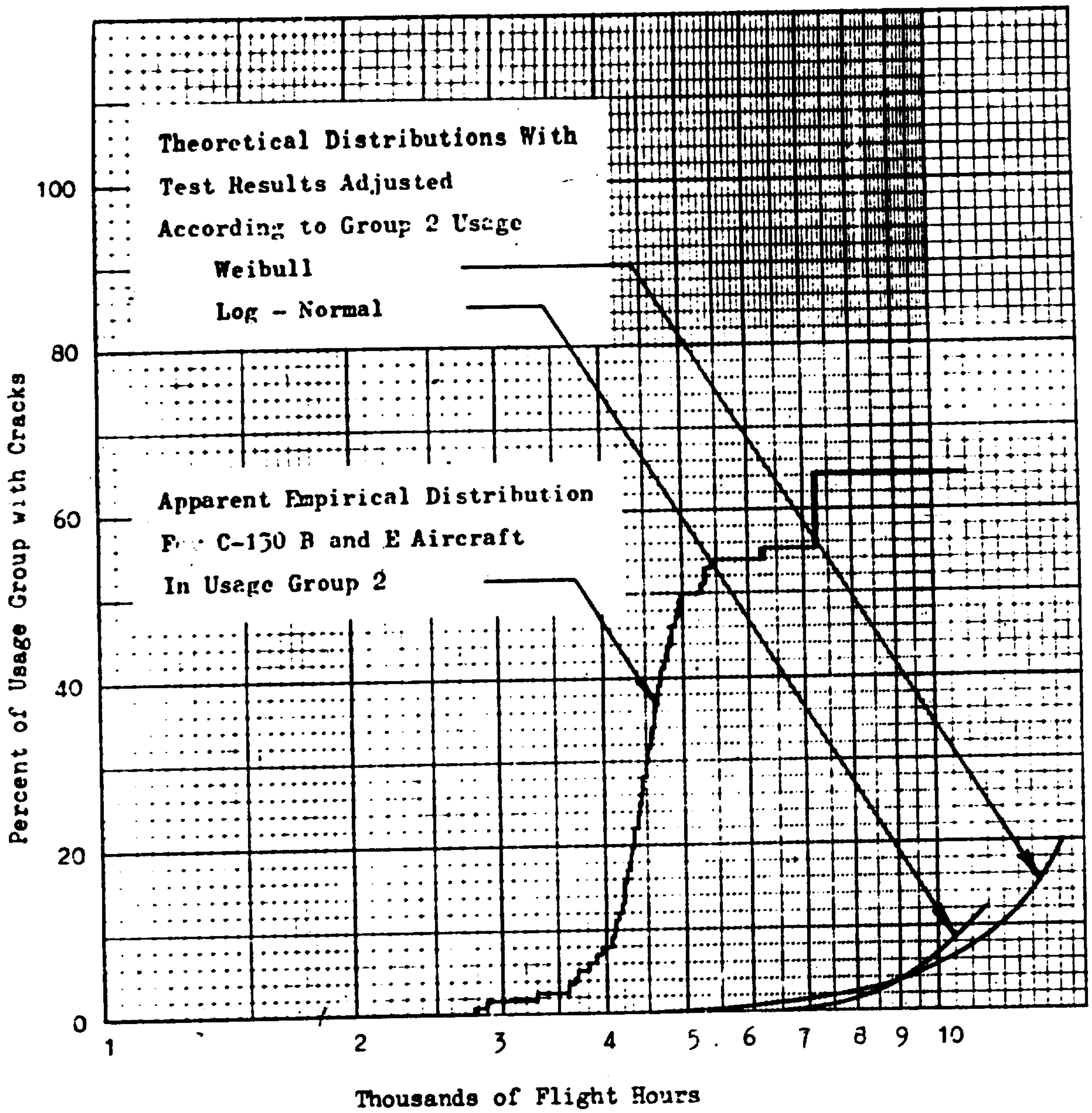


FIGURE 39 THEORETICAL DISTRIBUTION OF PROBABILITY OF TIME TO CRACK INITIATION ADJUSTED FOR GROUP 2 USAGE FOR CENTER WING UPPER SURFACE STATION 38

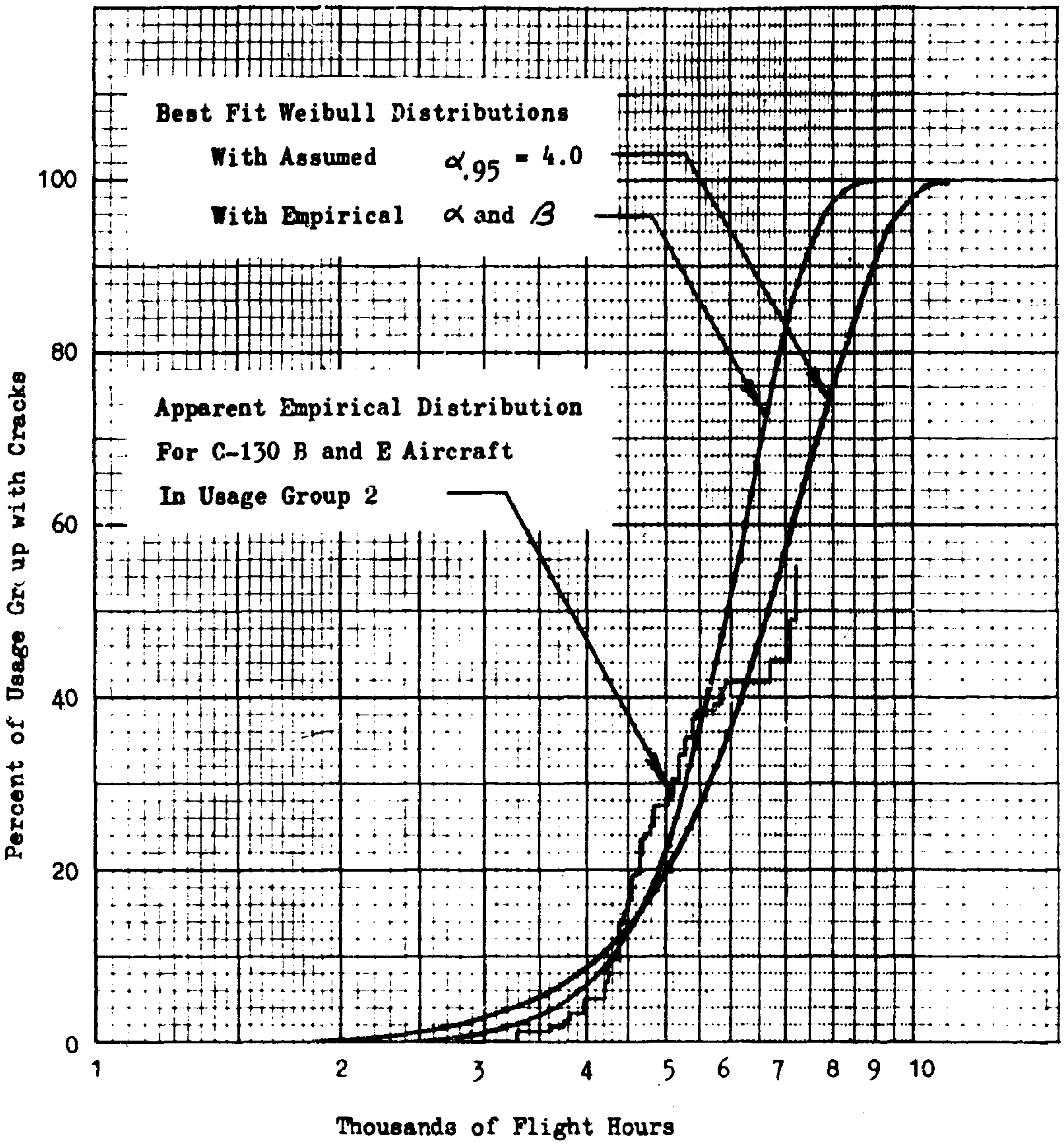


FIGURE 40 APPARENT AND BEST FIT WEIBULL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 105 FOR USAGE GROUP 2

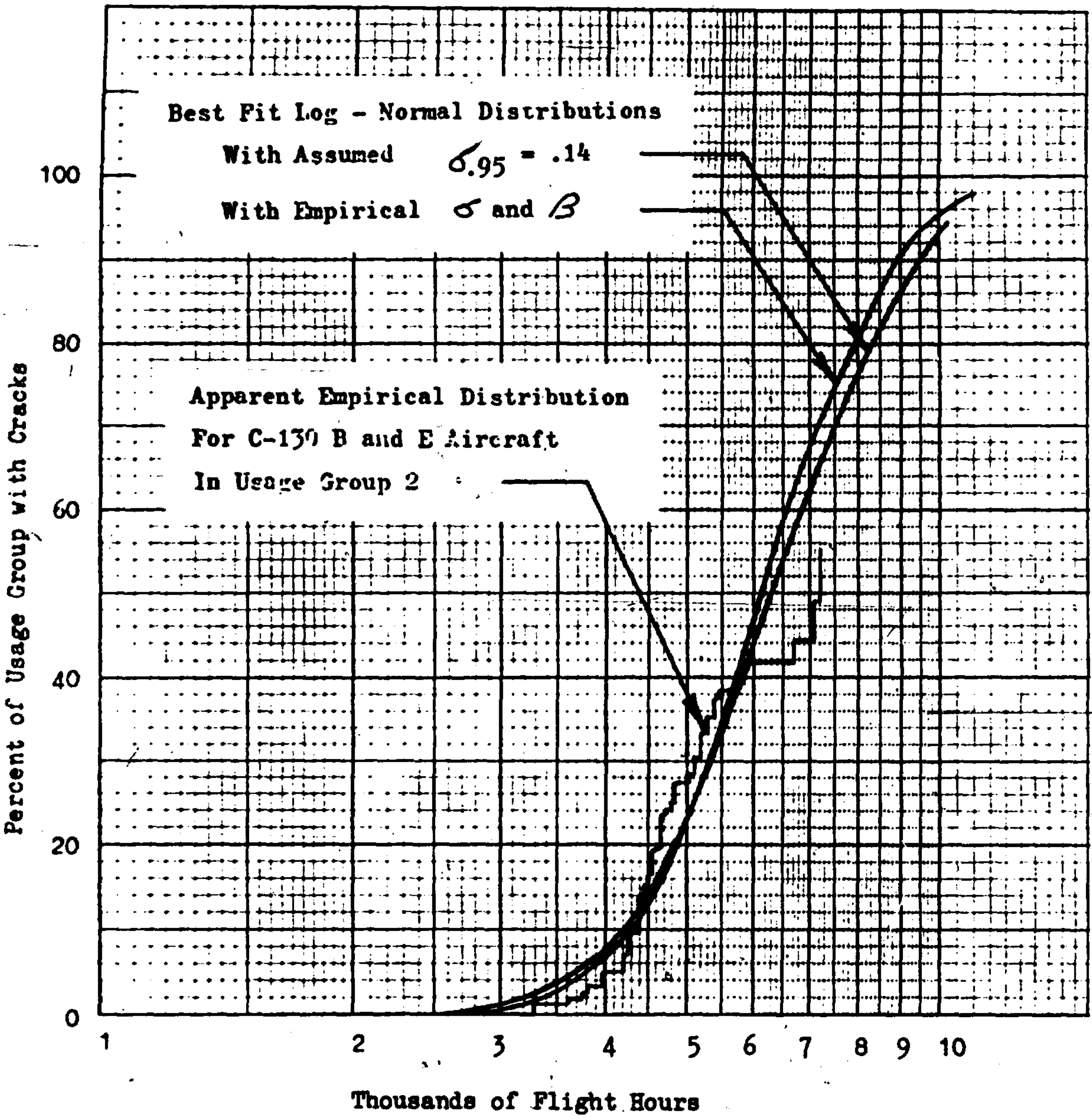


FIGURE 41 APPARENT AND BEST FIT LOG-NORMAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION [illegible] FOR USAGE GROUP 2

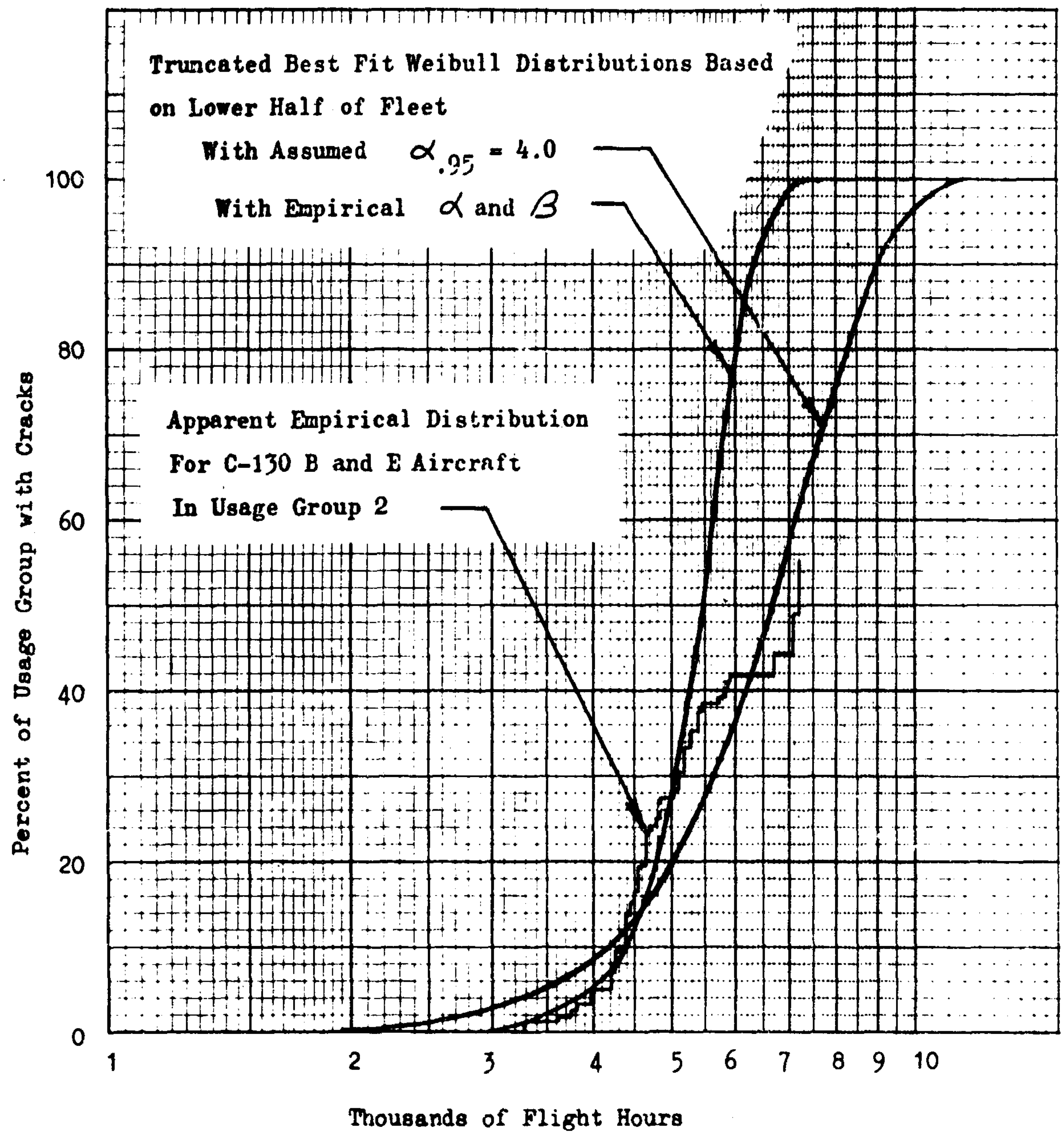


FIGURE 42 APPARENT AND TRUNCATED BEST FIT WEIBULL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 105 FOR USAGE GROUP 2

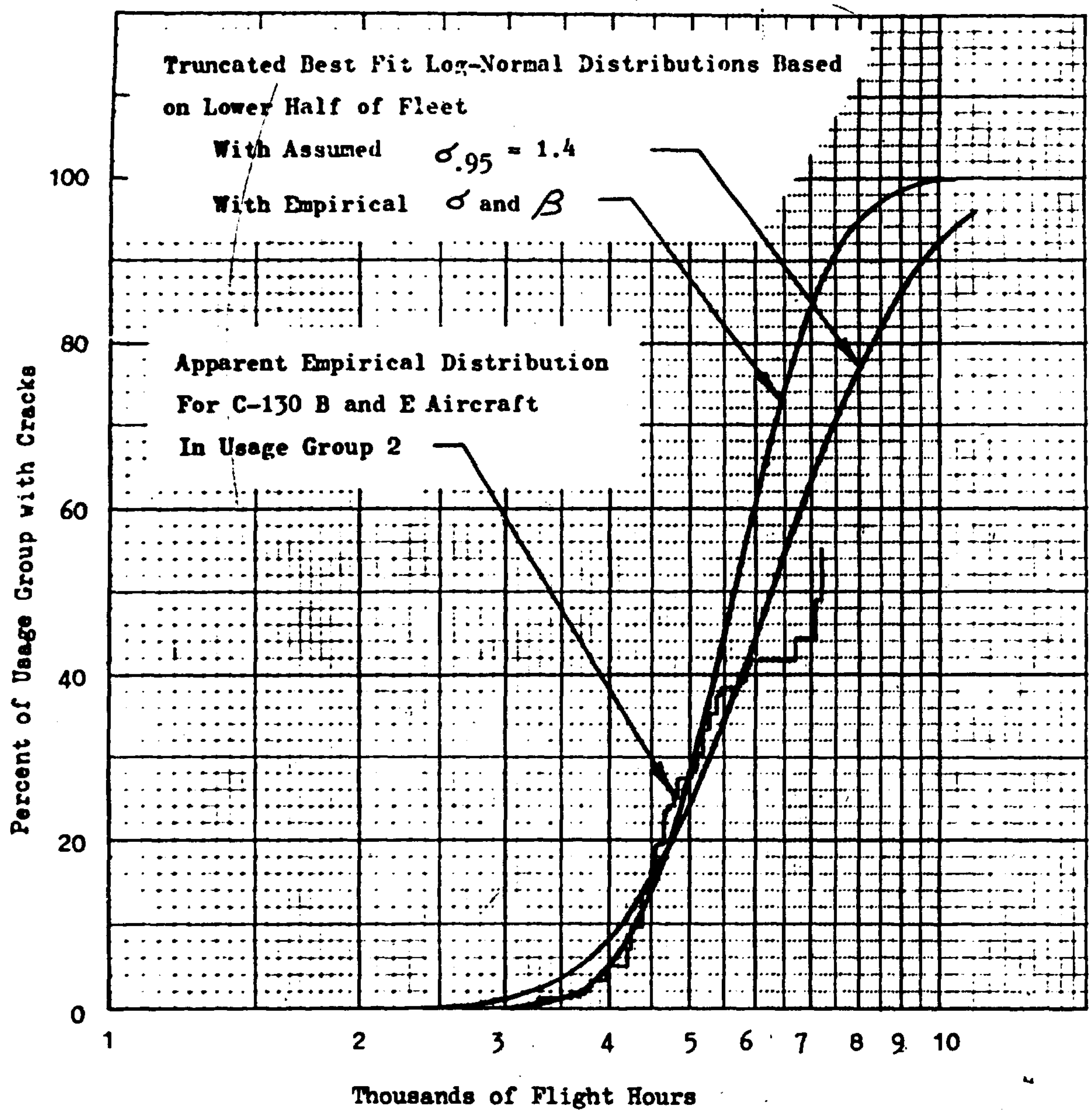


FIGURE 43 APPARENT AND TRUNCATED LOG NORMAL BEST FIT PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 105 FOR USAGE GROUP 2

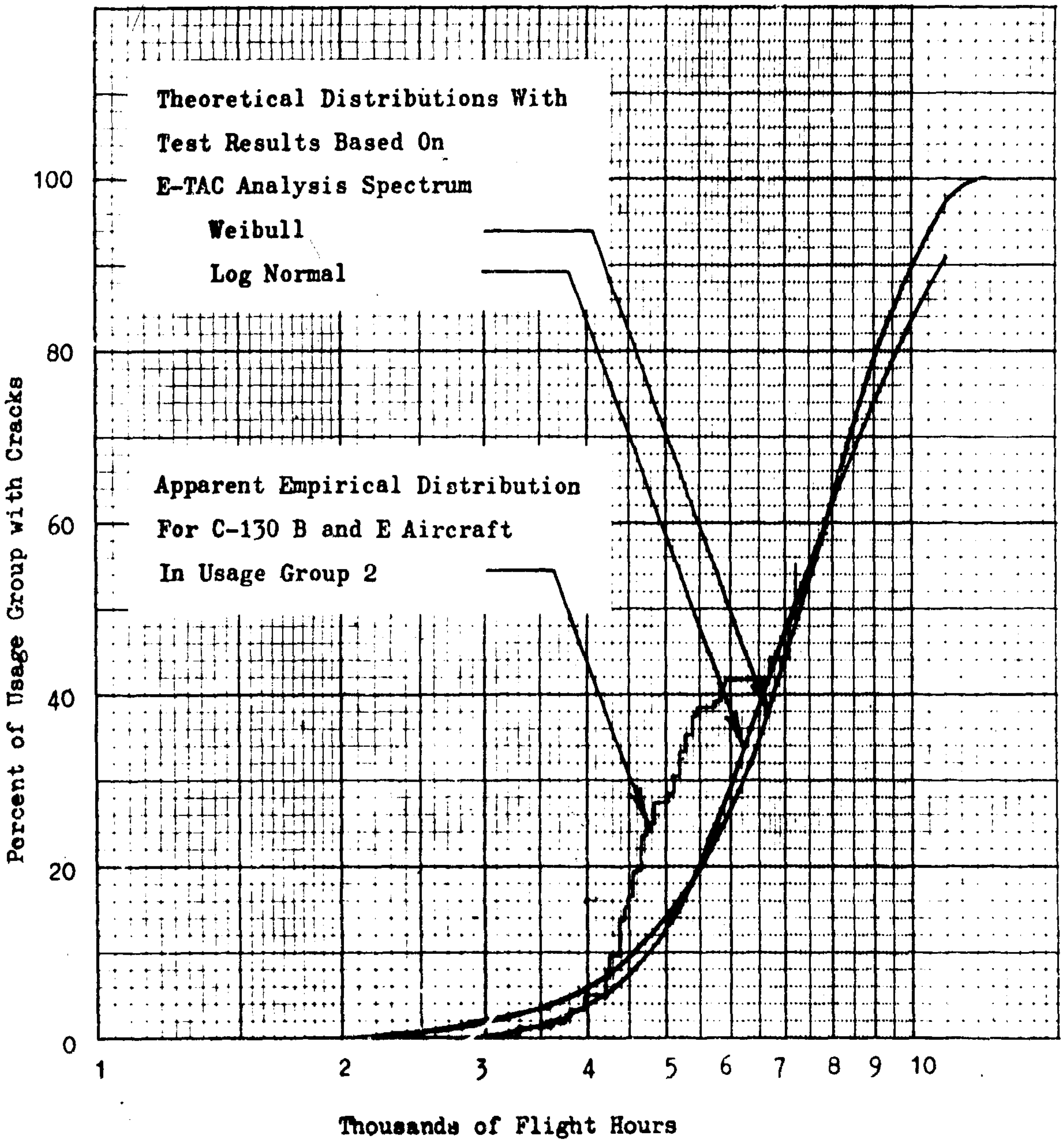


FIGURE 44 APPARENT AND THEORETICAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE WING STATION 105 FOR USAGE GROUP 2

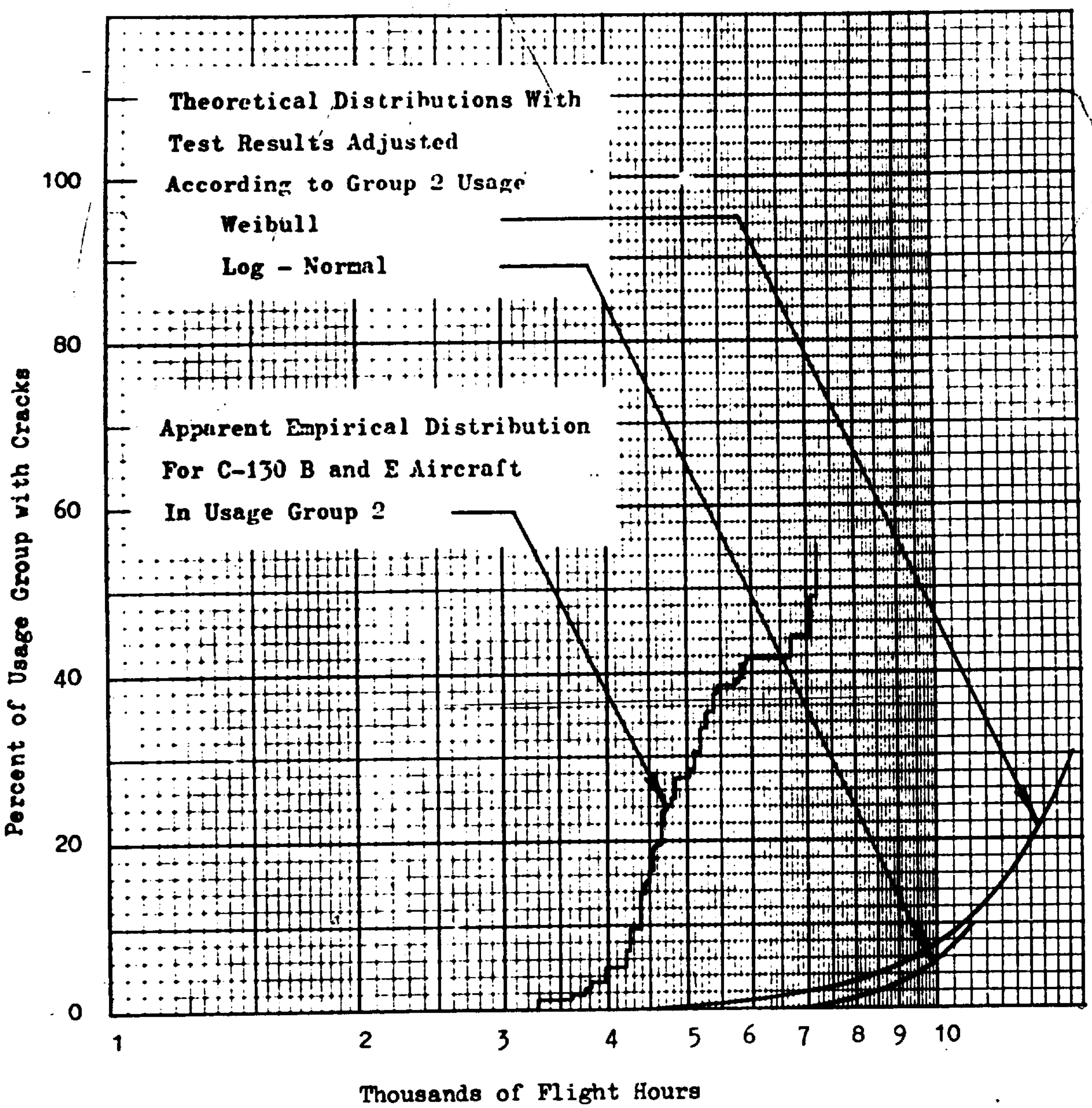


FIGURE 45 THEORETICAL DISTRIBUTION OF PROBABILITY OF TIME TO CRACK INITIATION ADJUSTED FOR GROUP 2 USAGE FOR CENTER WING UPPER SURFACE STATION 105

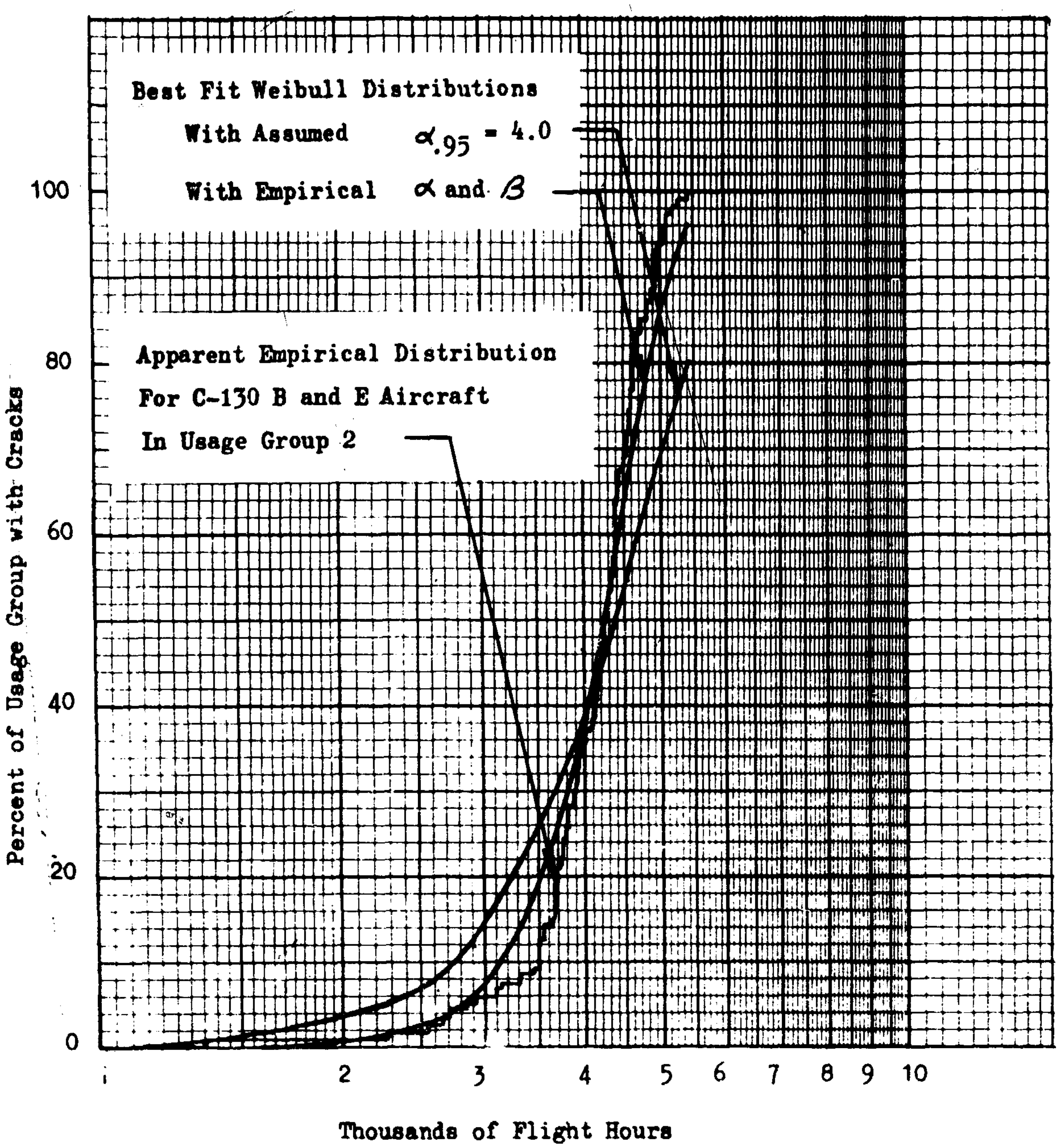


FIGURE 46 APPARENT AND BEST FIT WEIBULL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING LOWER SURFACE STATION 121 FOR USAGE GROUP 2

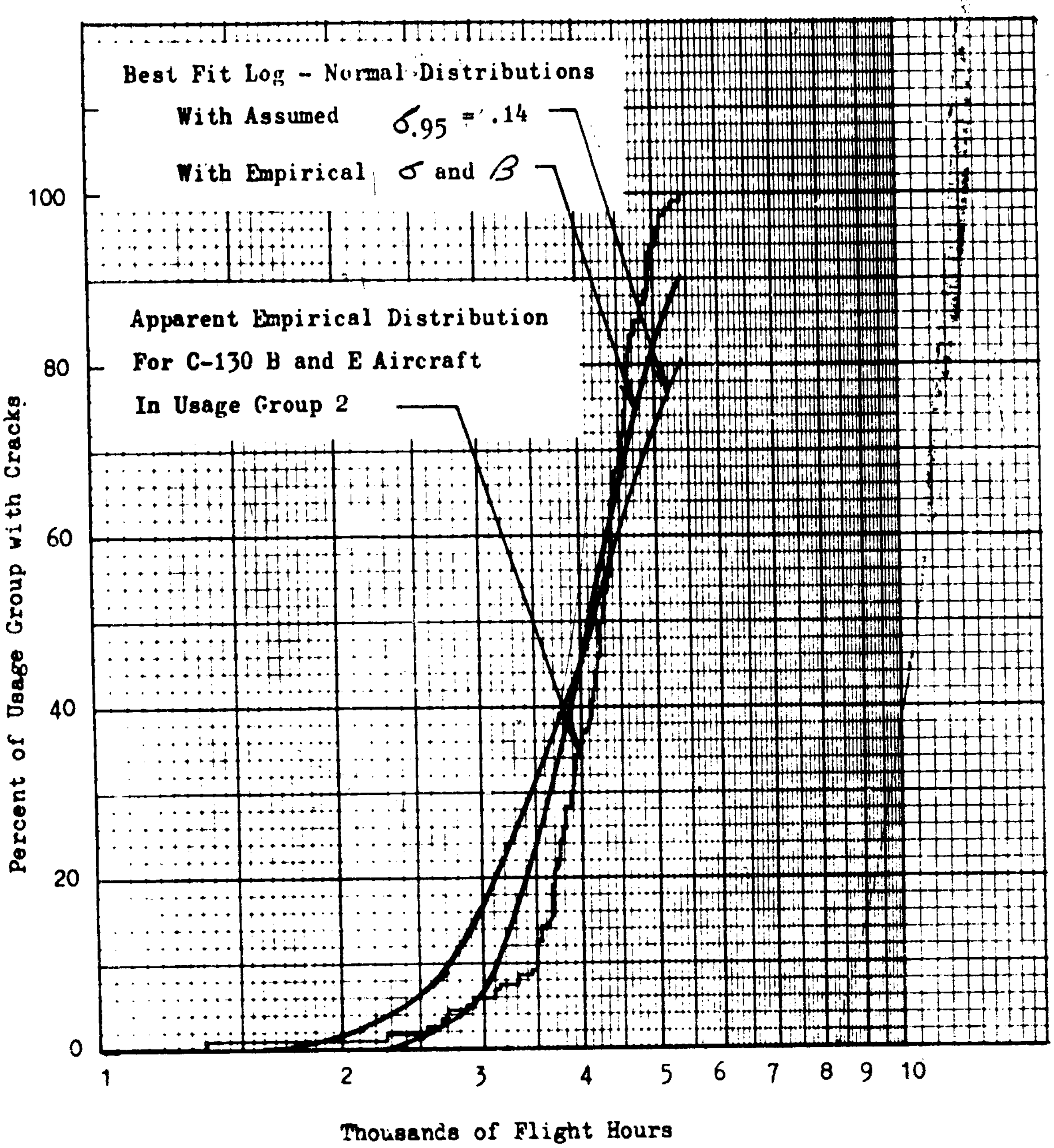


FIGURE 47 APPARENT AND BEST FIT LOG-NORMAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING LOWER SURFACE STATION 121 FOR USAGE GROUP 2

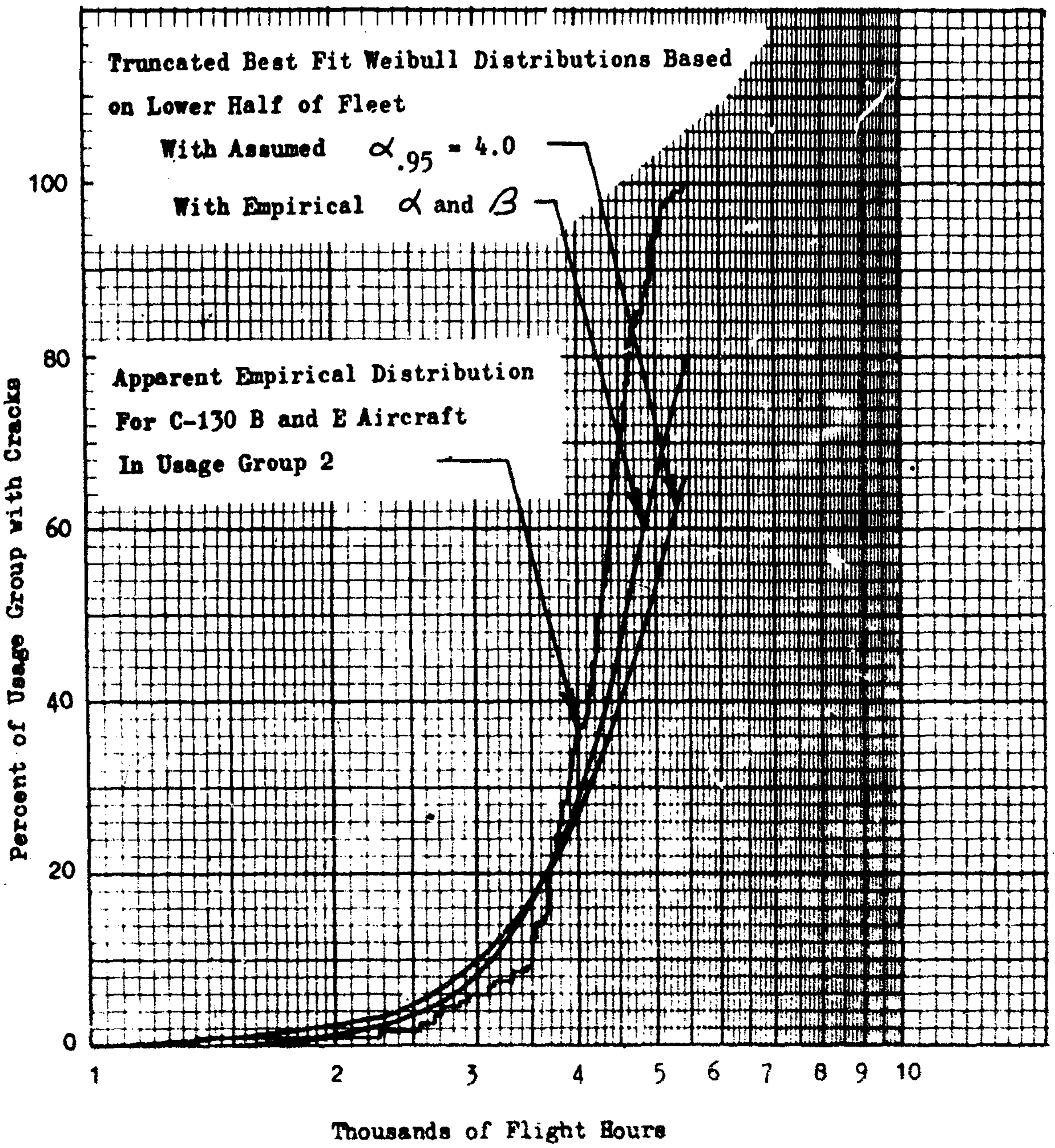


FIGURE 48 APPARENT AND TRUNCATED BEST FIT WEIBULL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING LOWER SURFACE STATION 121 FOR USAGE GROUP 2

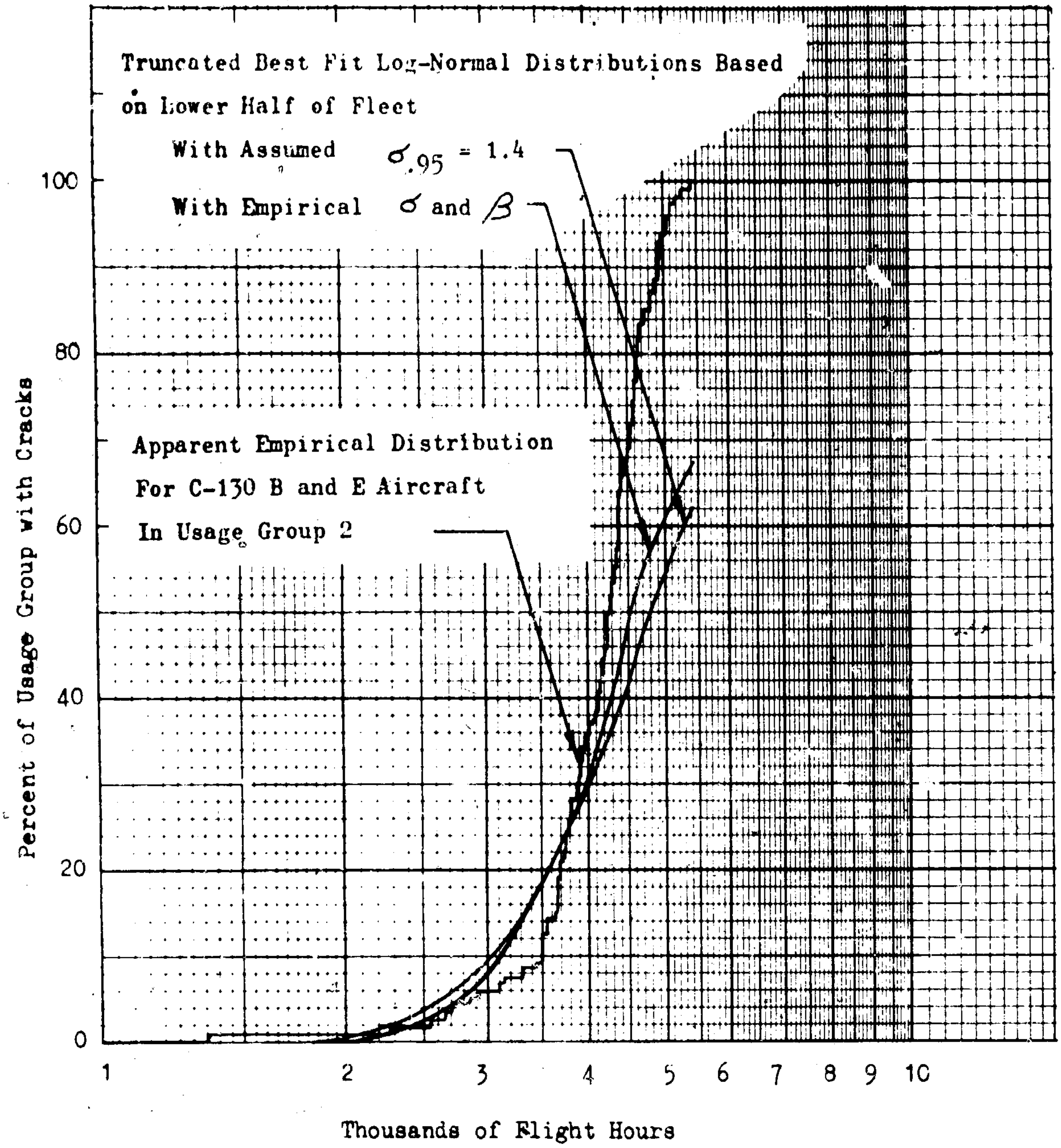


FIGURE 49 APPARENT AND TRUNCATED BEST FIT LOG-NORMAL PROBABILITY DISTRIBUTIONS OF TO CRACK INITIATION AT C-130 CENTER WING LOWER SURFACE STATION 121 FOR USAGE GROUP 2

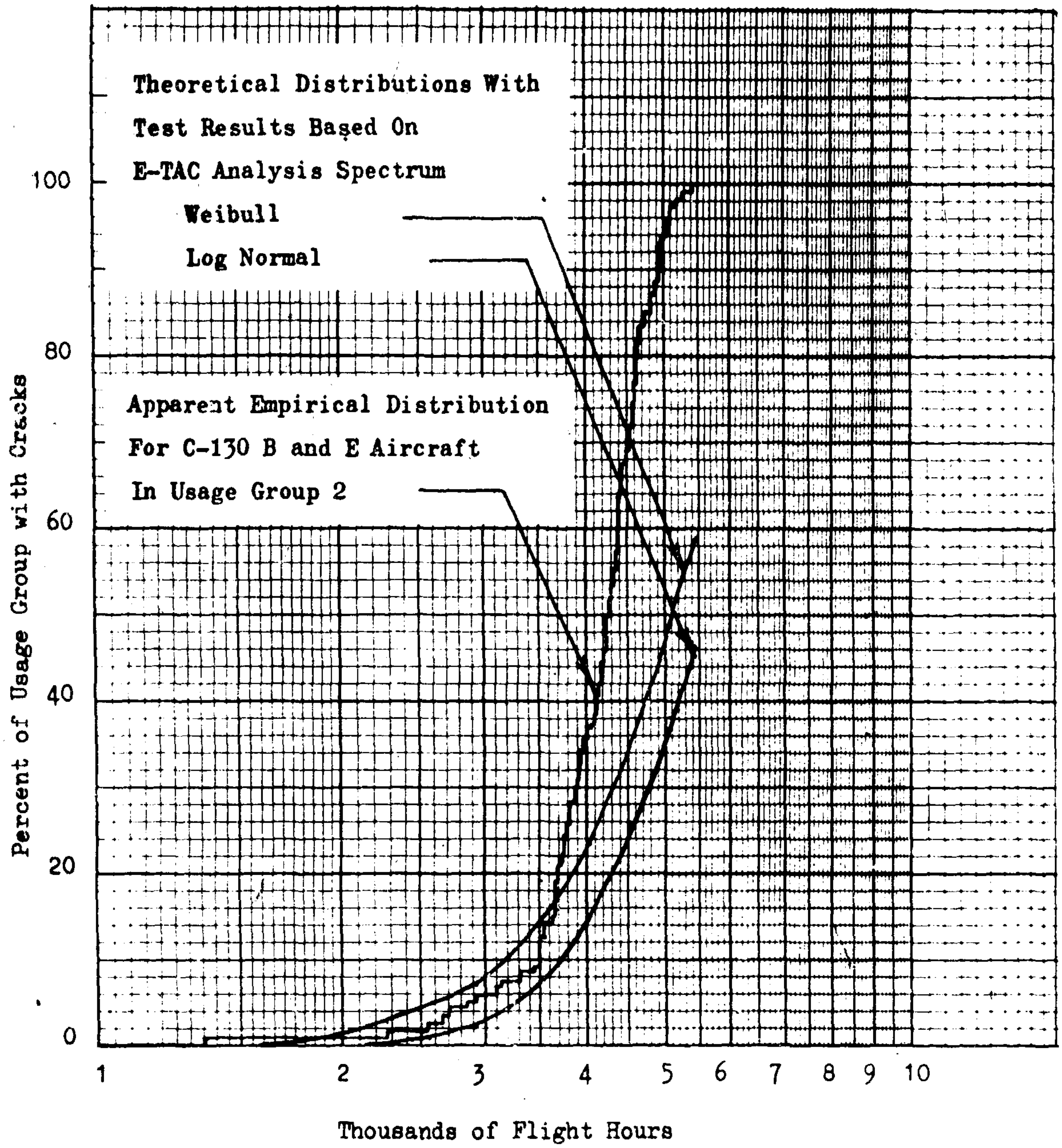


FIGURE 50 APPARENT AND THEORETICAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING LOWER SURFACE STATION 121 FOR USAGE GROUP 2

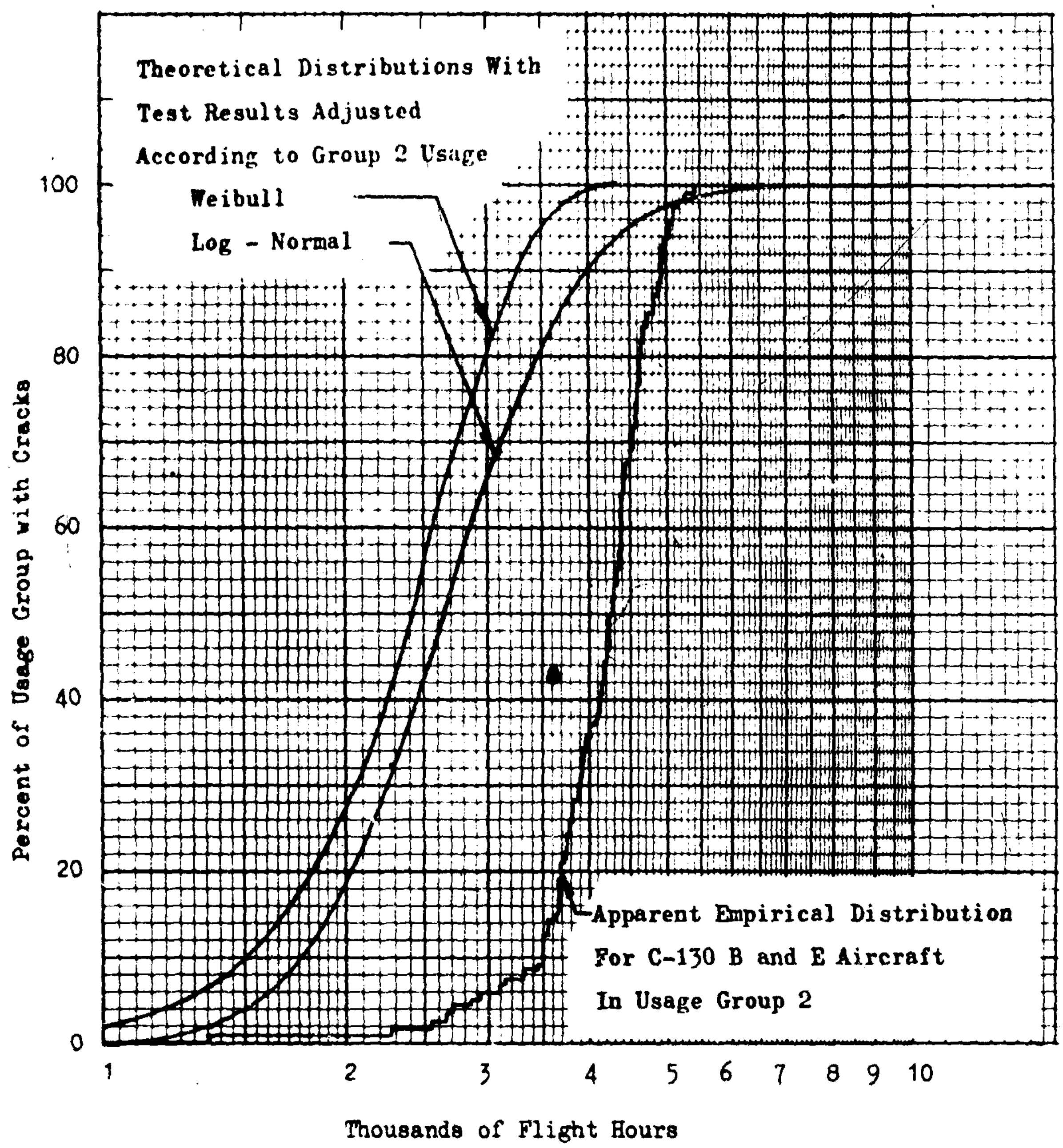


FIGURE 51 THEORETICAL DISTRIBUTION OF PROBABILITY OF TIME TO CRACK INITIATION ADJUSTED FOR GROUP 2 USAGE FOR CENTER WING LOWER SURFACE STATION 121

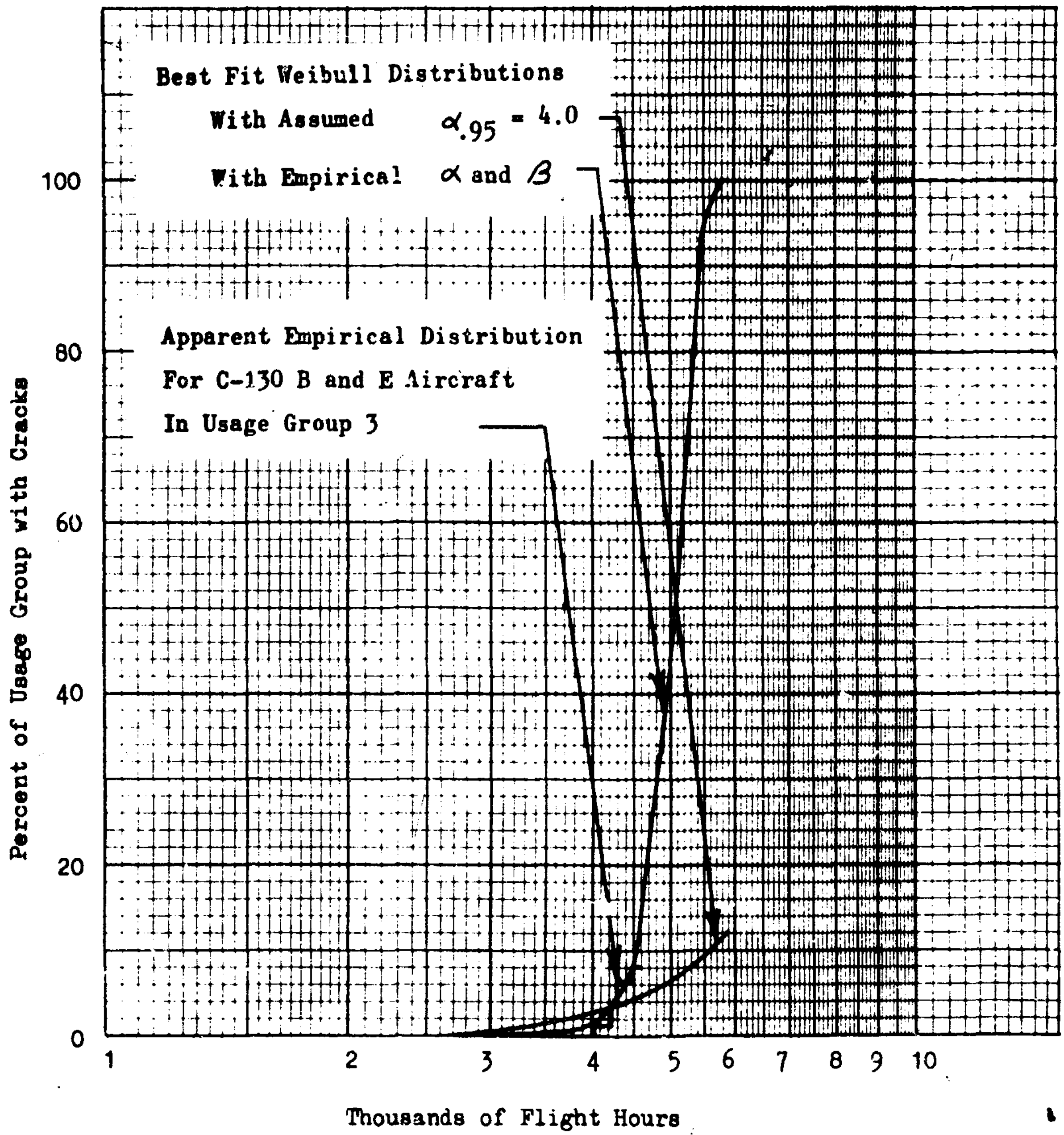


FIGURE 52 APPARENT AND BEST FIT WEIBULL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 38 FOR USAGE GROUP 3

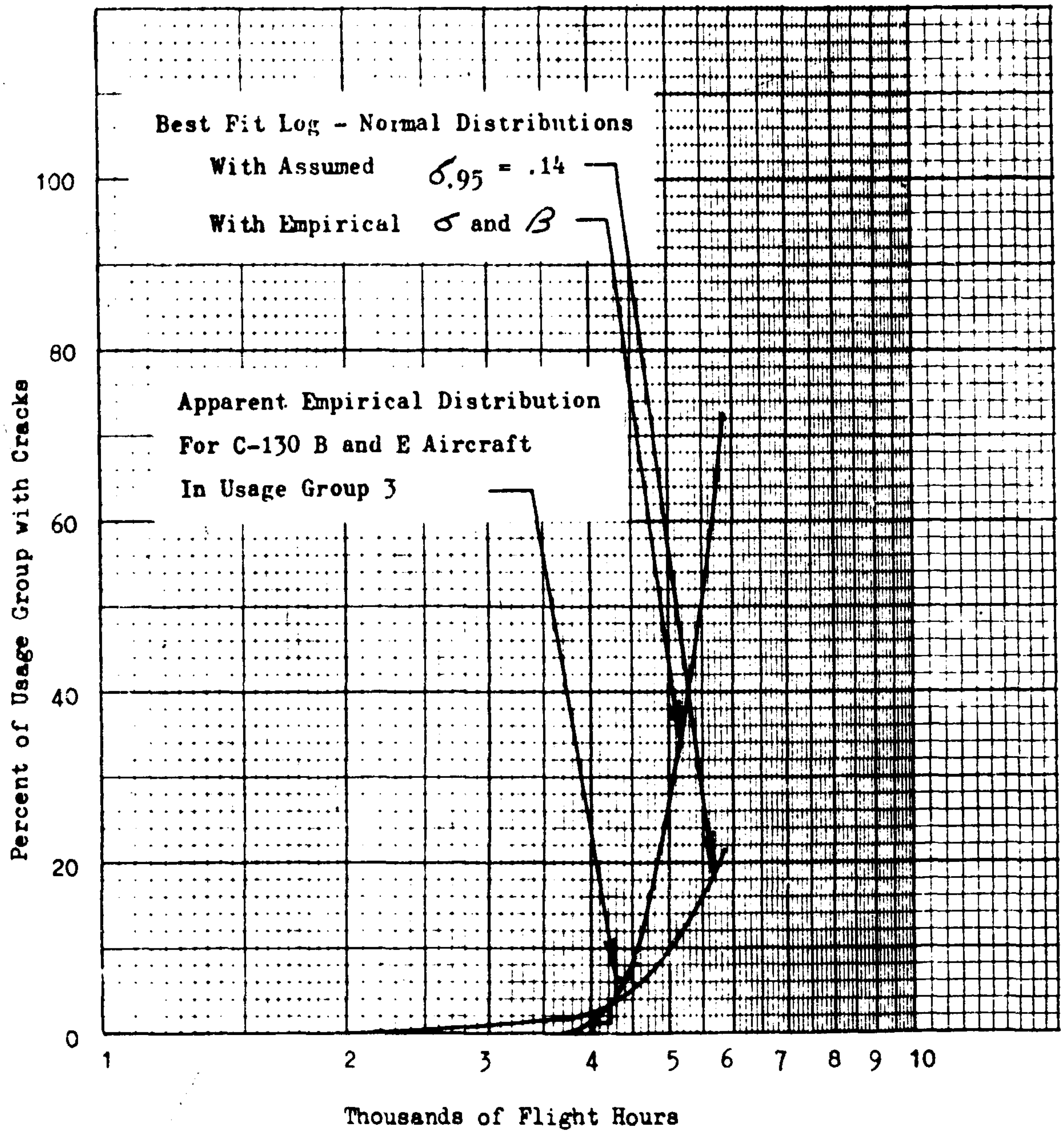


FIGURE 53 APPARENT AND BEST FIT LOG-NORMAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 38 FOR USAGE GROUP 3

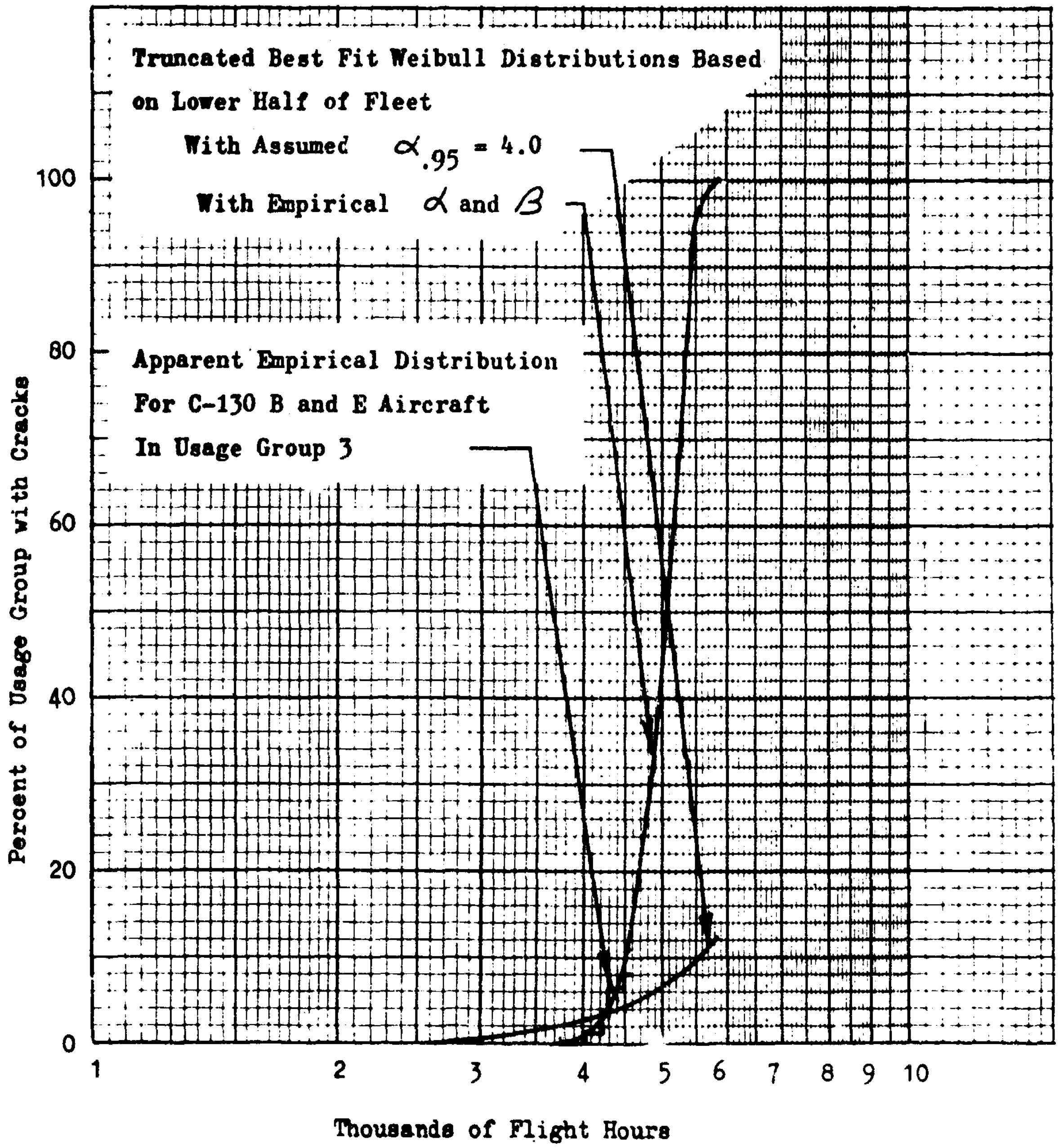


FIGURE 54 APPARENT AND TRUNCATED BEST FIT WEIBULL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 38 FOR USAGE GROUP 3

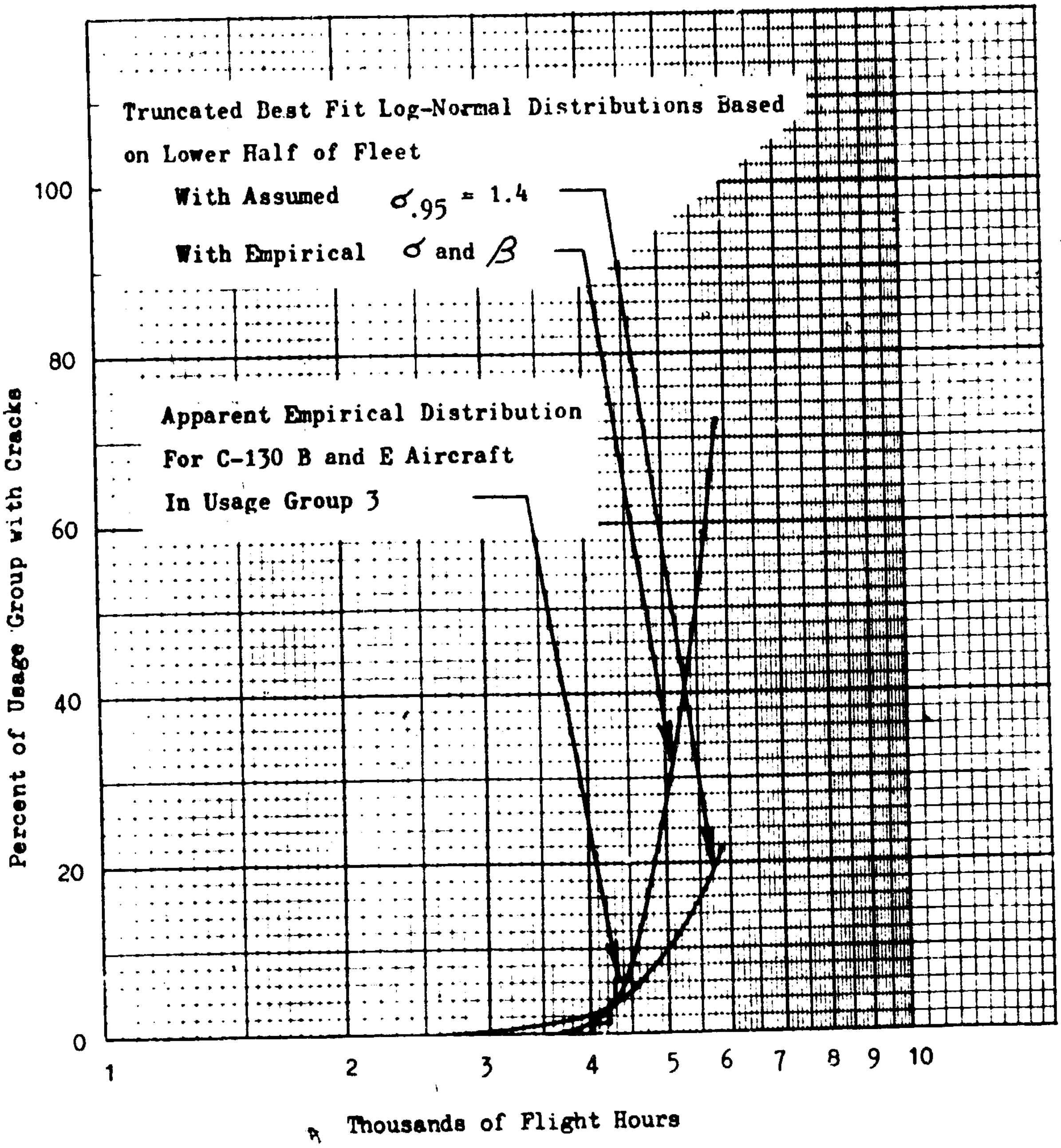


FIGURE 55 APPARENT AND TRUNCATED BEST FIT LOG-NORMAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 38 FOR USAGE GROUP 3

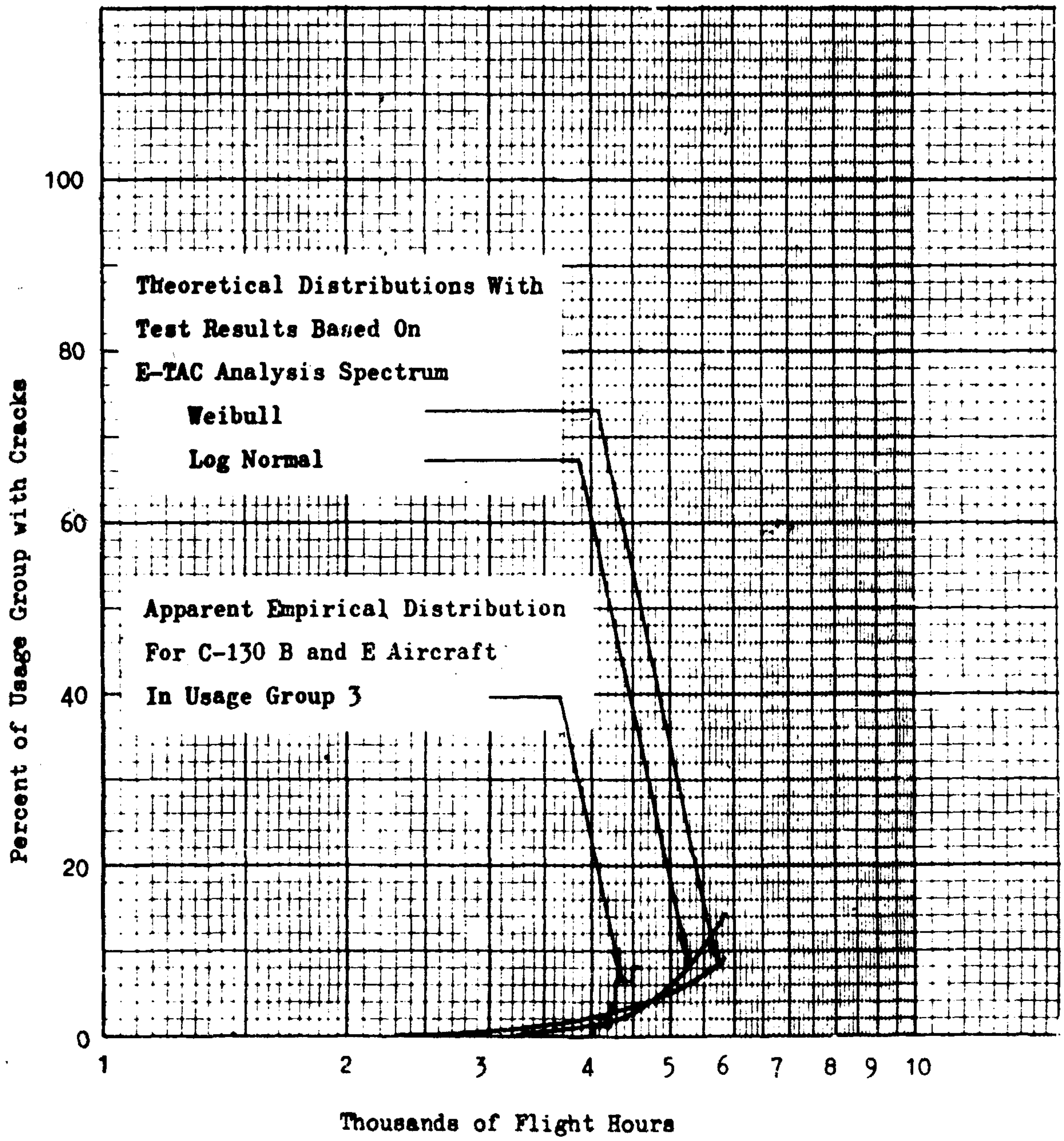


FIGURE 56 APPARENT AND THEORETICAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 38 FOR USAGE GROUP 3

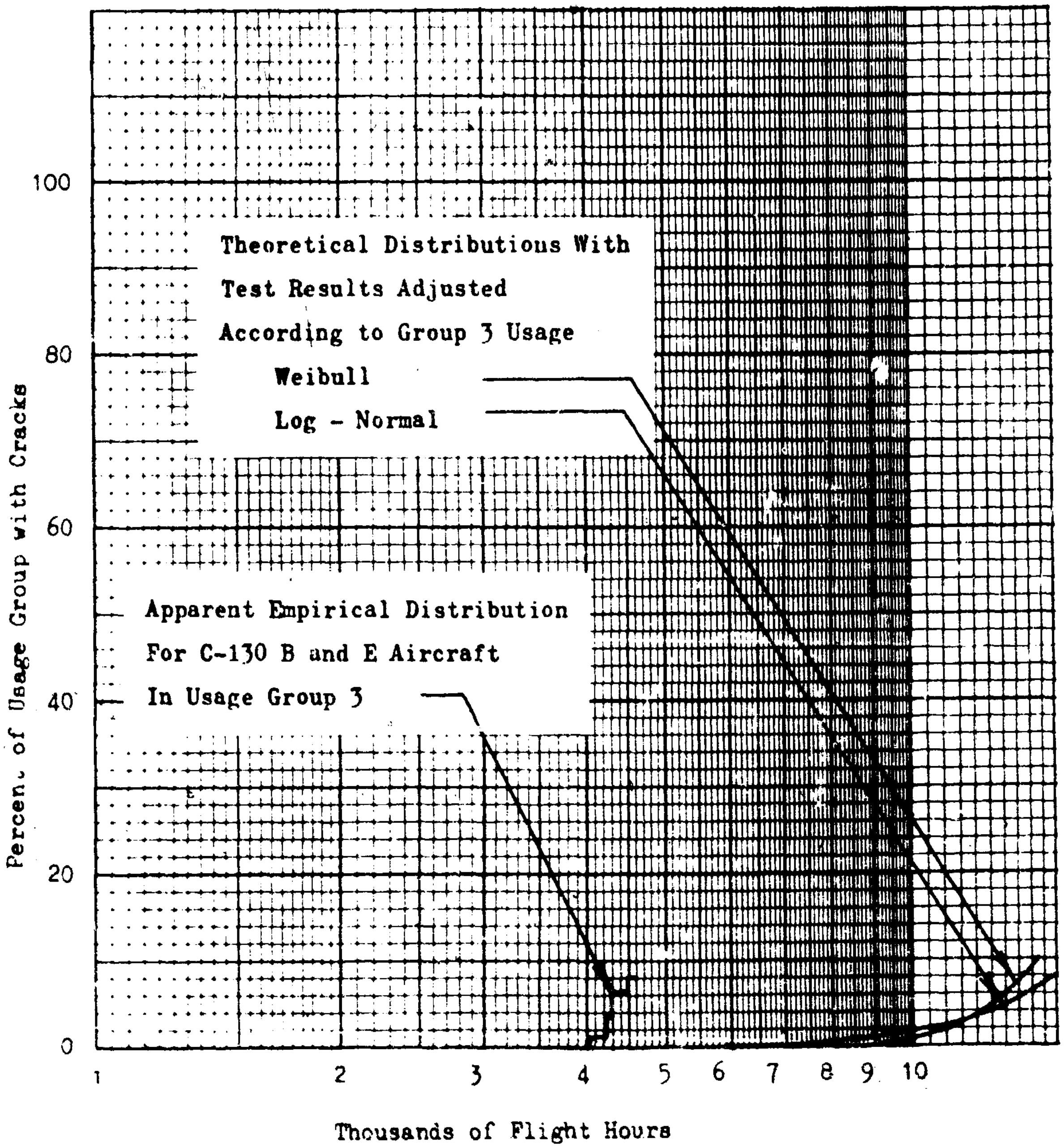


FIGURE 57 THEORETICAL DISTRIBUTION OF PROBABILITY OF TIME TO CRACK INITIATION ADJUSTED FOR GROUP 3 USAGE FOR CENTER WING UPPER SURFACE STATION 38

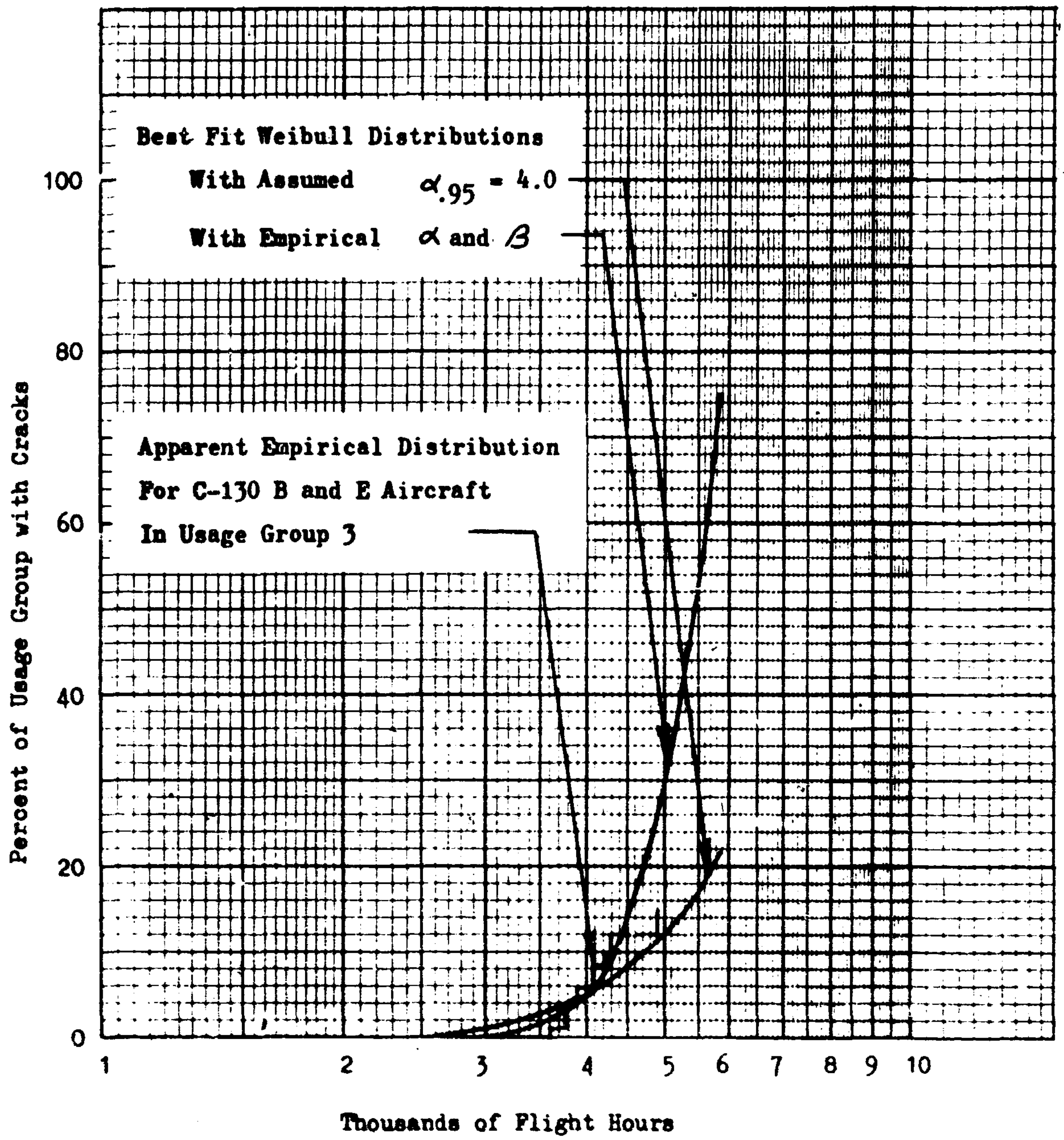


FIGURE 58 APPARENT AND BEST FIT WEIBULL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 105 FOR USAGE GROUP 3

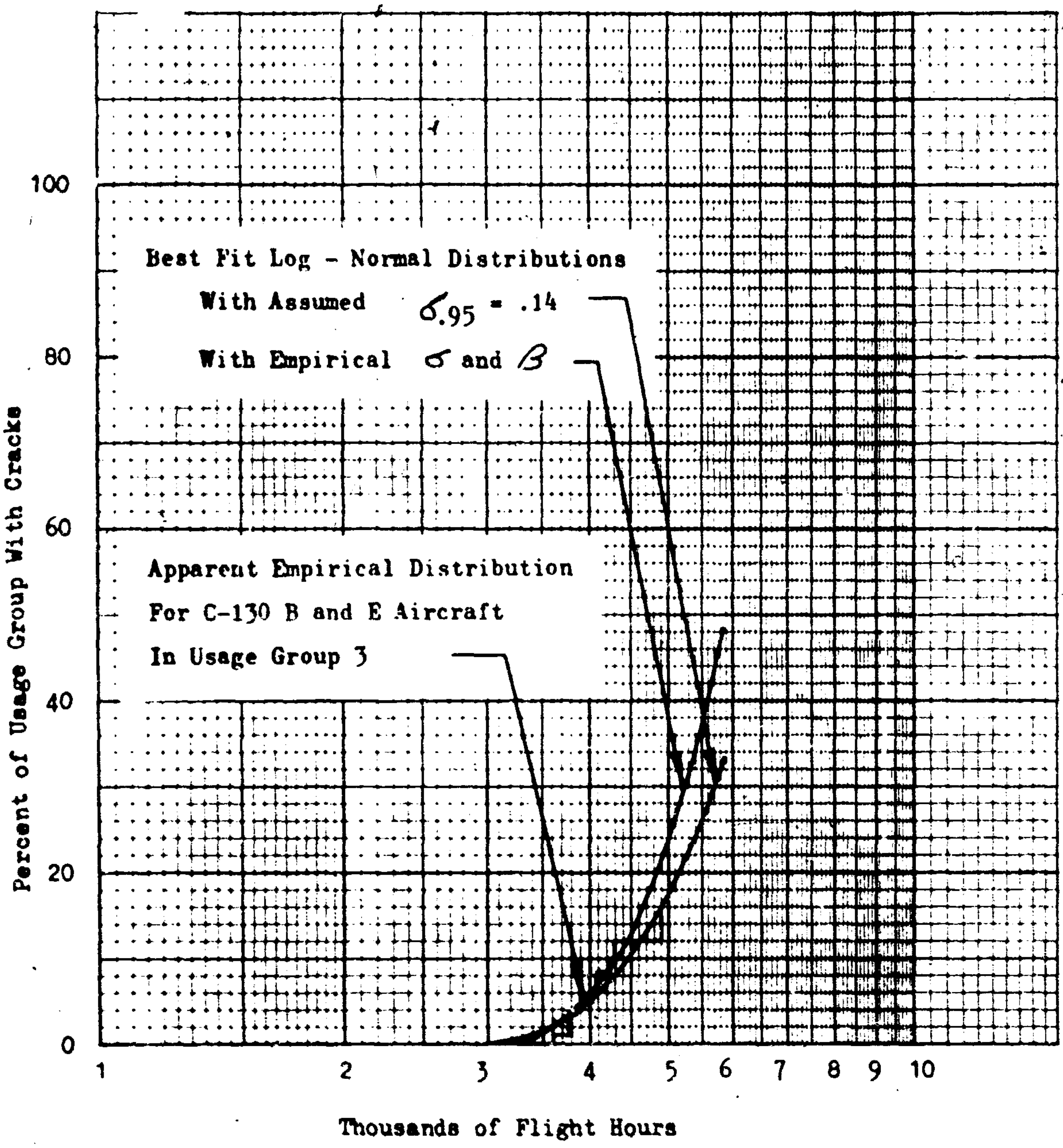


FIGURE 59 APPARENT AND BEST FIT LOG-NORMAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 105 FOR USAGE GROUP 3

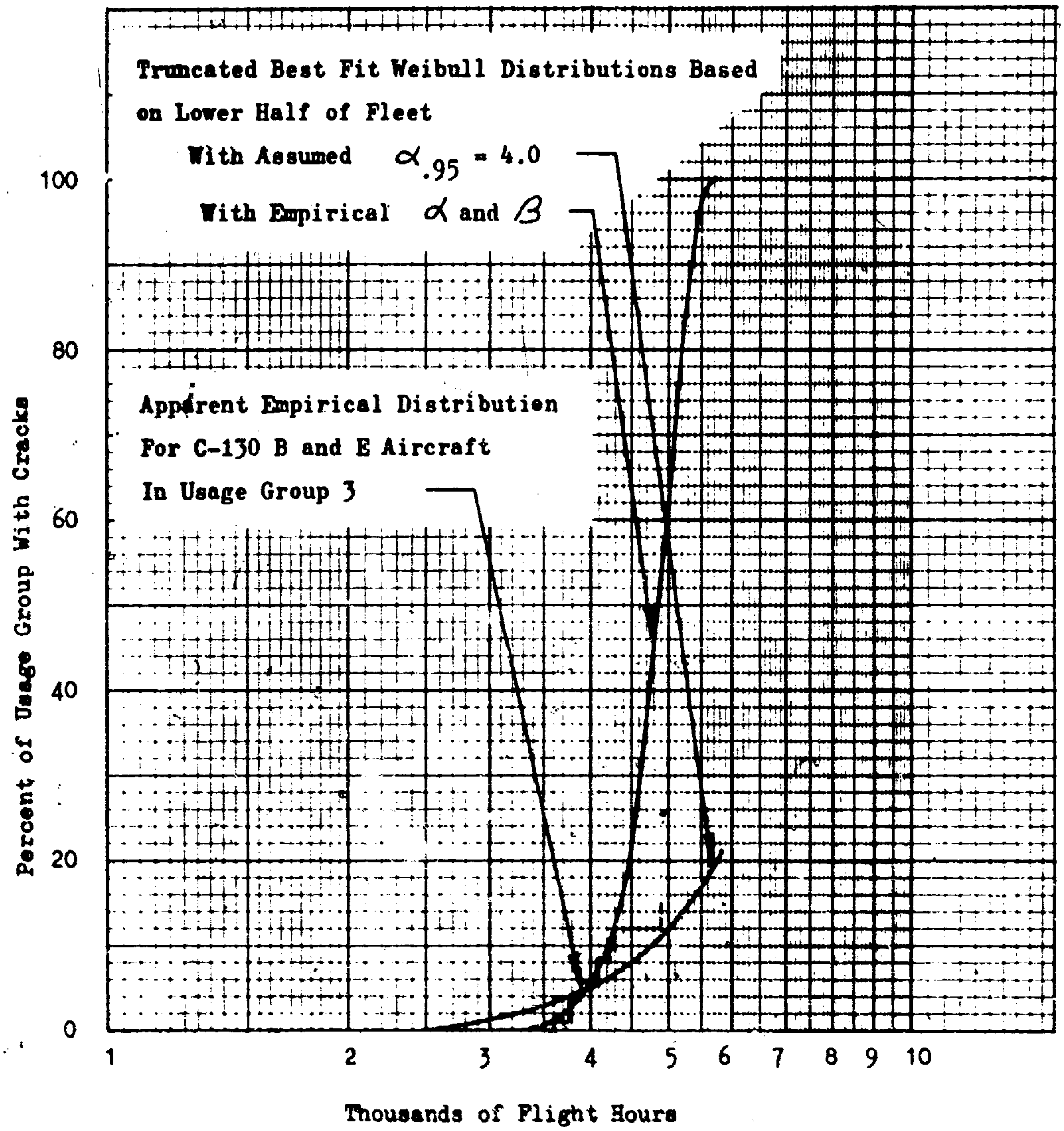


FIGURE 60 APPARENT AND TRUNCATED BEST FIT WEIBULL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 105 FOR USAGE GROUP 3

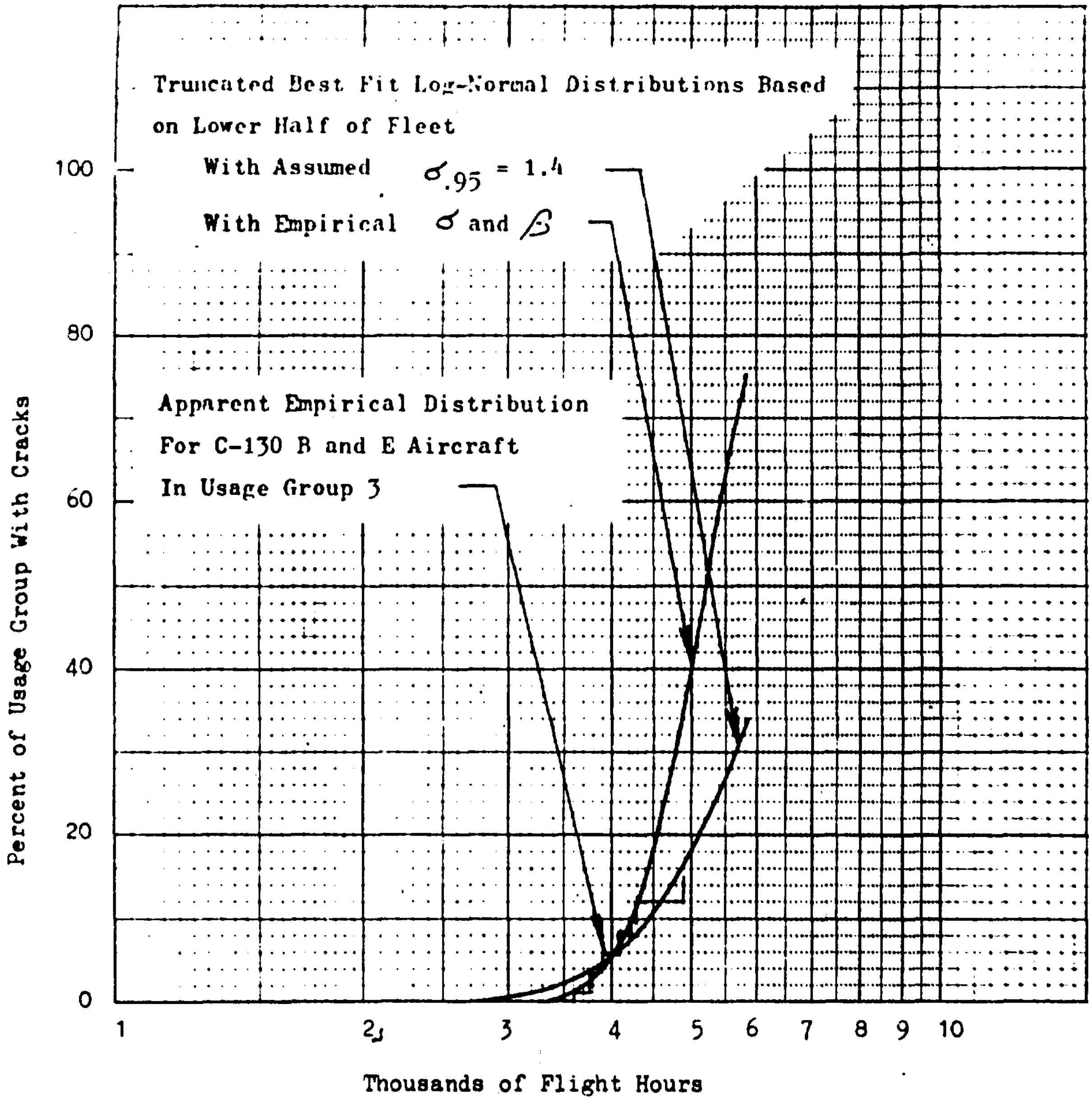


FIGURE 61 APPARENT AND TRUNCATED BEST FIT LOG-NORMAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 105 FOR USAGE GROUP 3

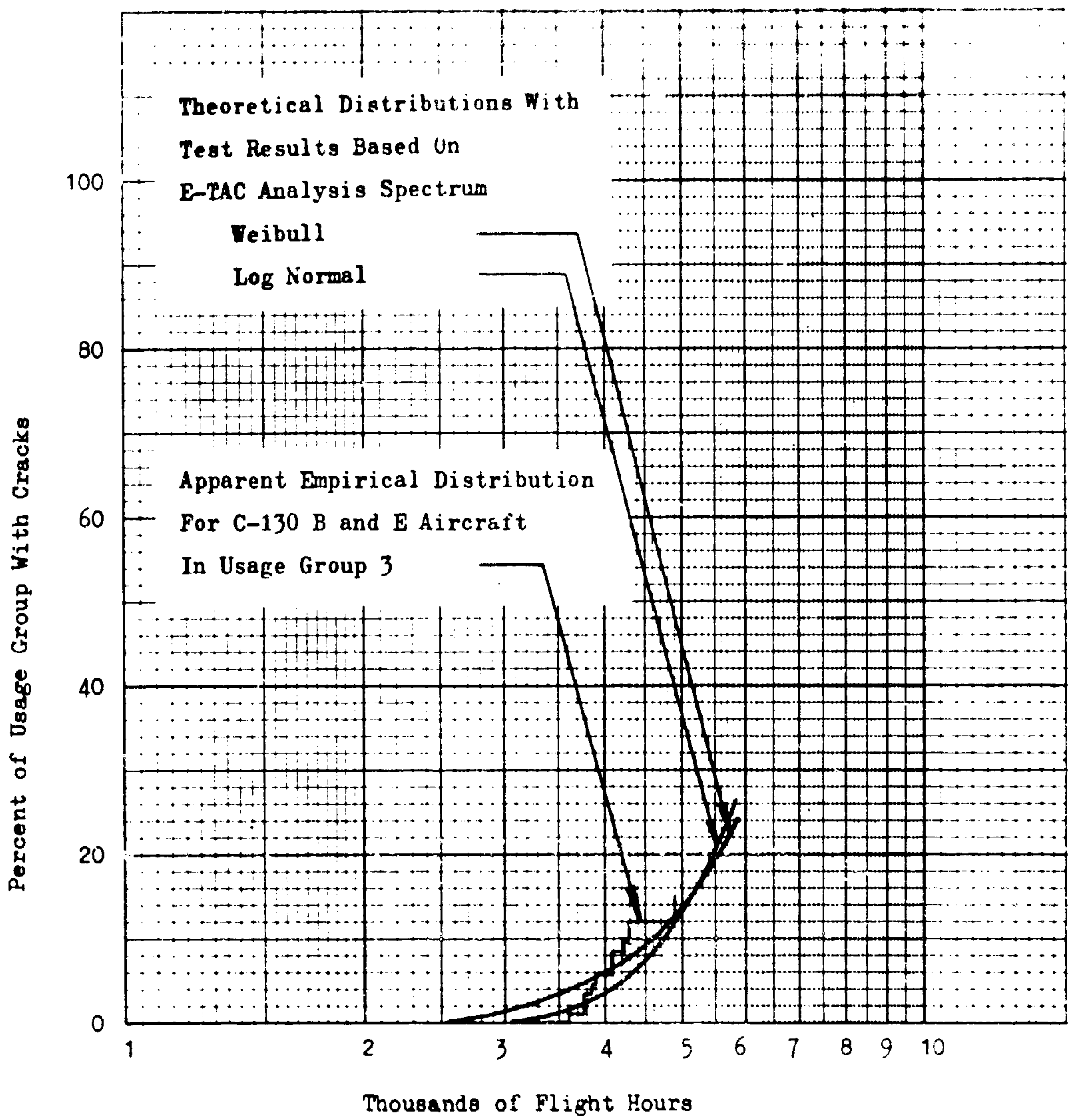


FIGURE 62 APPARENT AND THEORETICAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 105 FOR USAGE GROUP 3

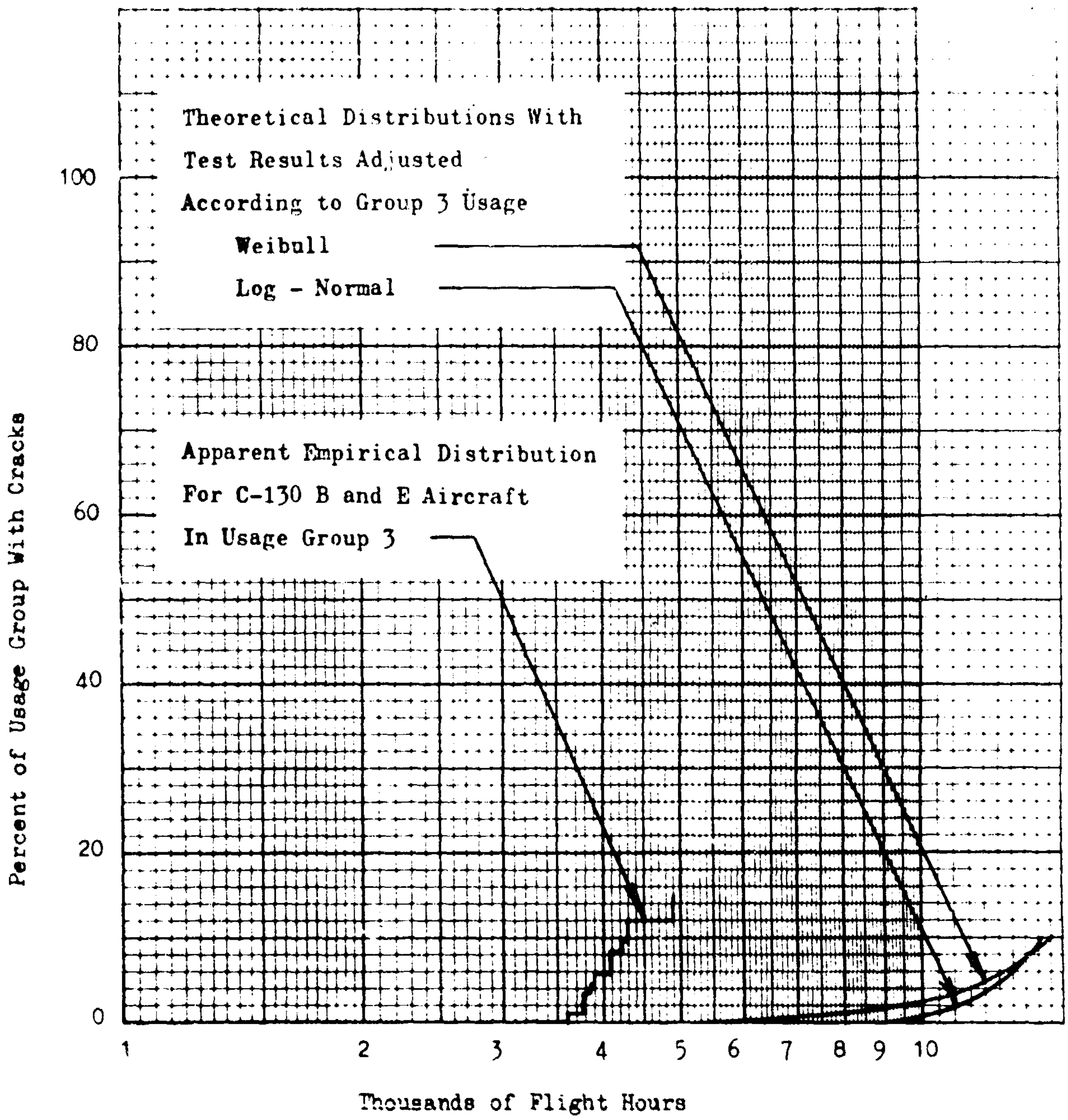


FIGURE 63 THEORETICAL DISTRIBUTION OF TIME TO CRACK INITIATION ADJUSTED FOR GROUP 3 USAGE FOR CENTER WING UPPER SURFACE STATION 105

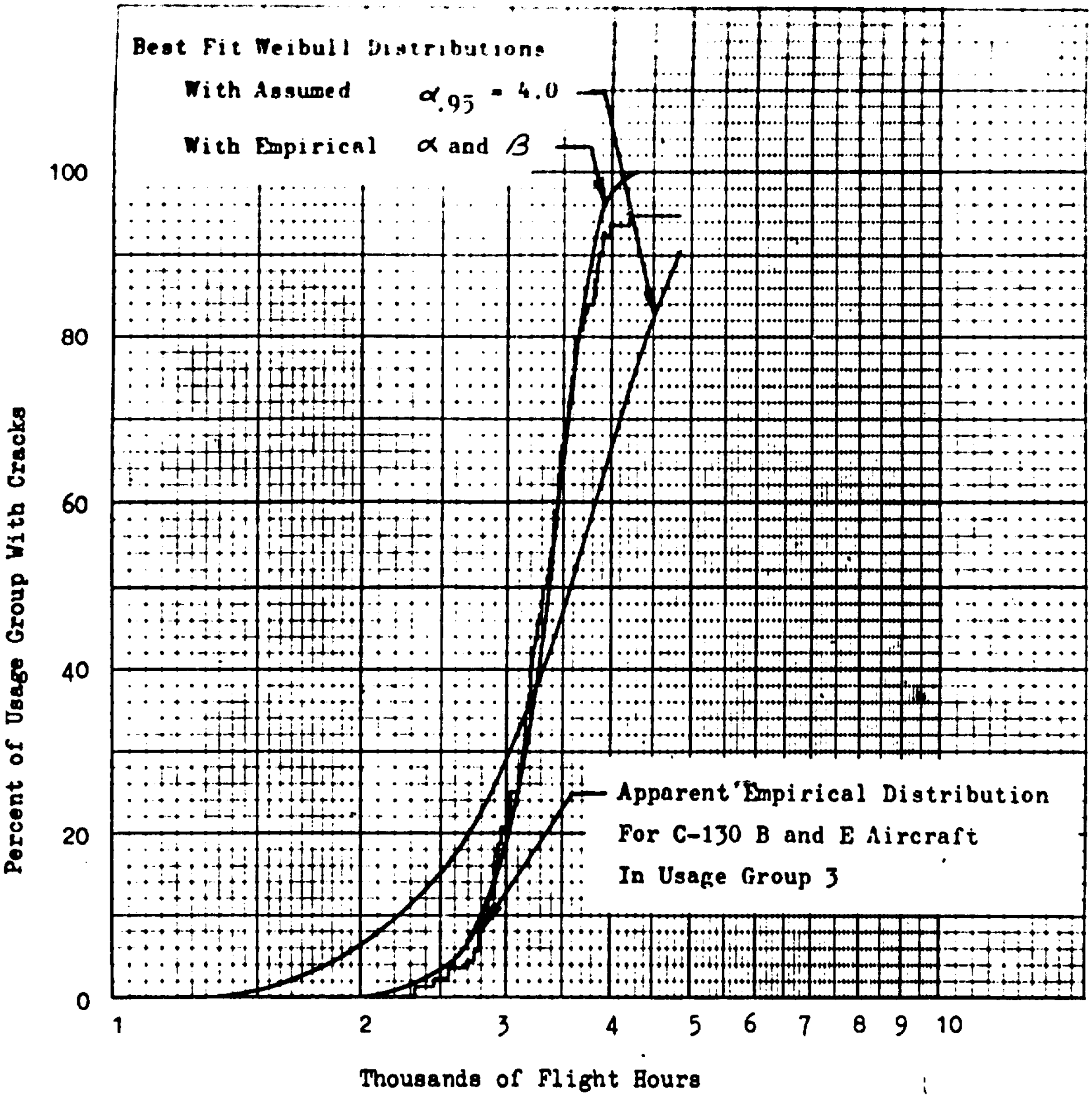


FIGURE 64 APPARENT AND BEST FIT WEIBULL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING LOWER SURFACE STATION 121 FOR USAGE GROUP 3

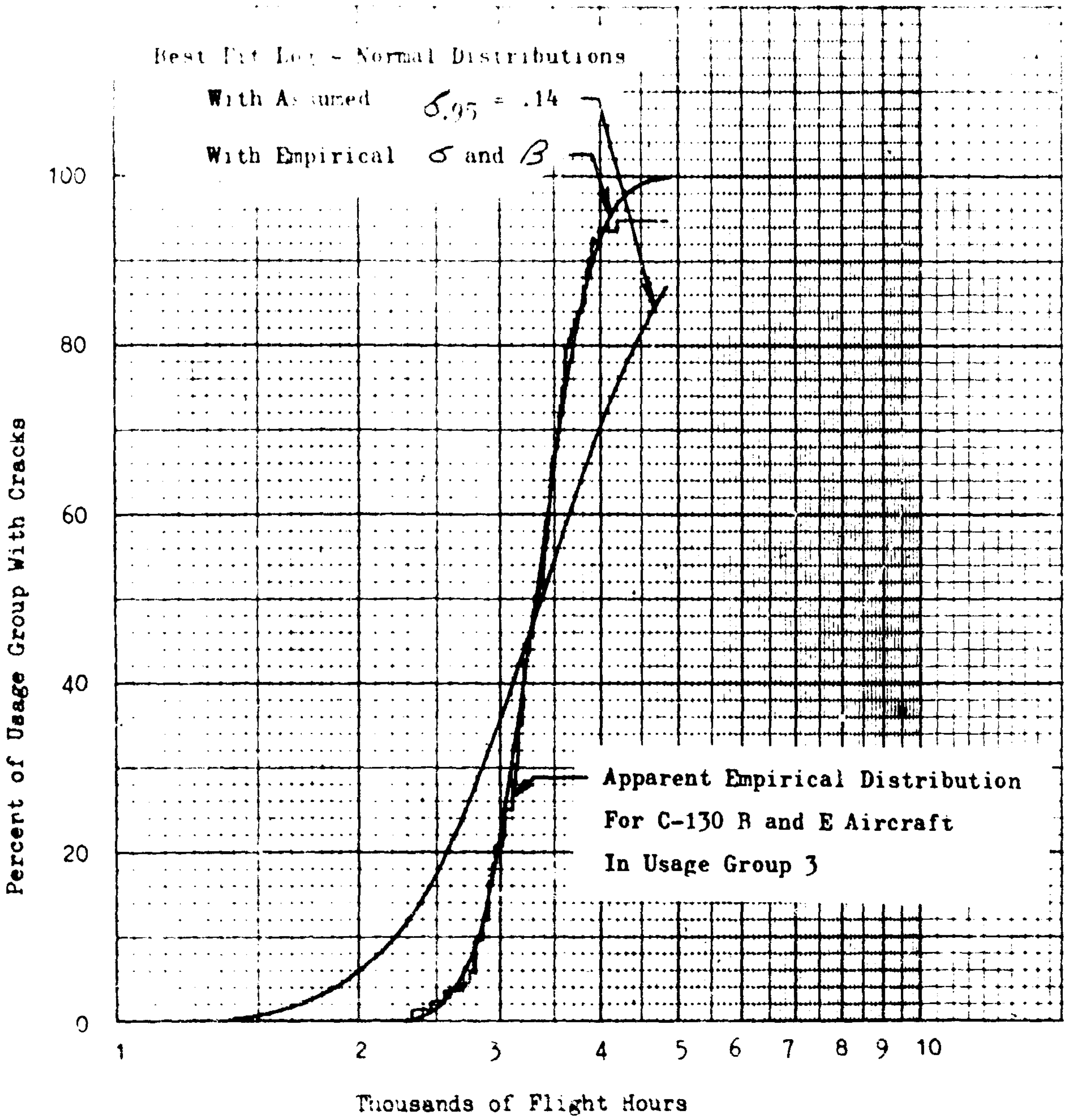


FIGURE 65 APPARENT AND BEST FIT LOG-NORMAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING LOWER SURFACE STATION 121 FOR USAGE GROUP 3

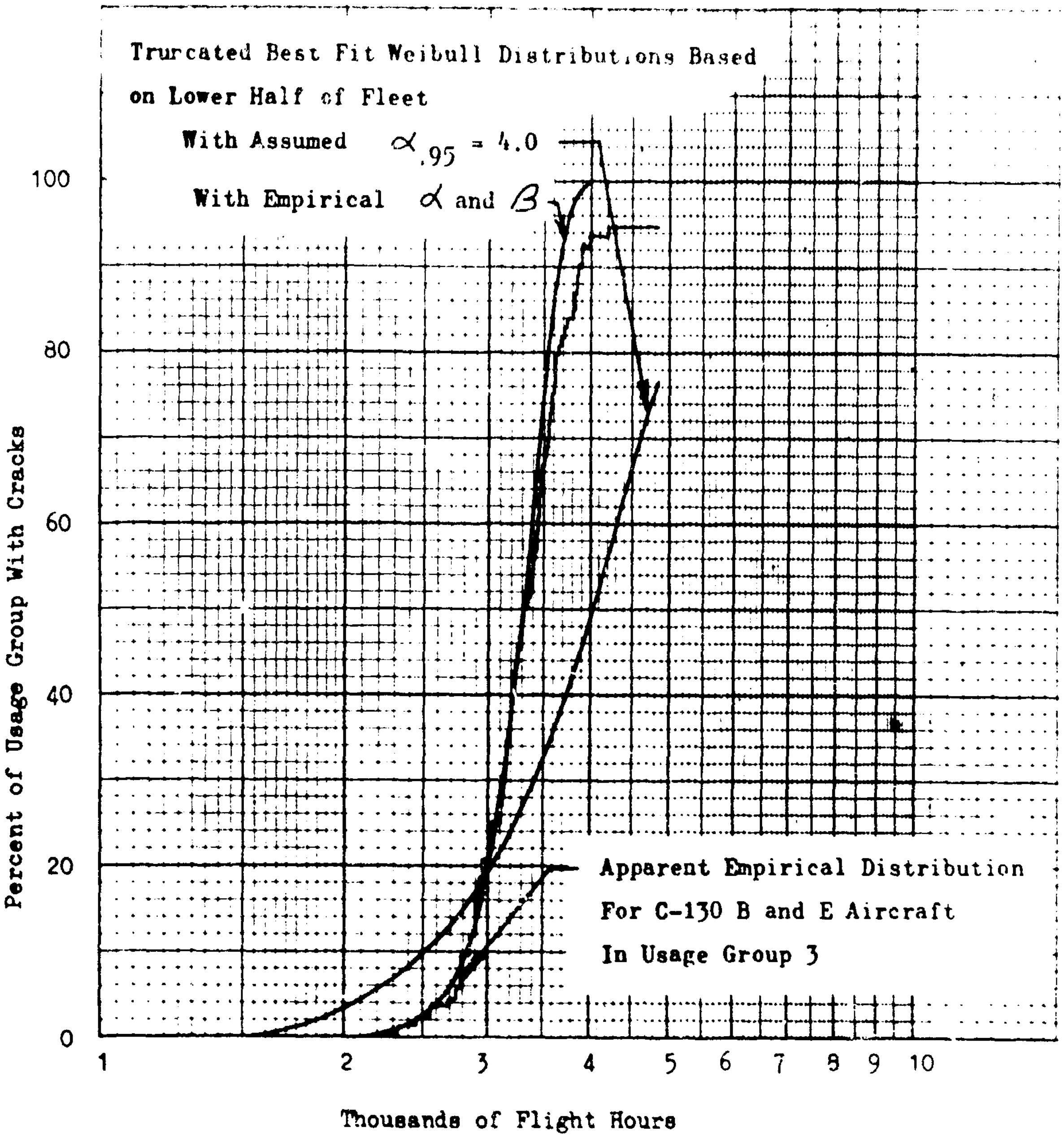


FIGURE 66 APPARENT AND TRUNCATED BEST FIT WEIBULL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING LOWER SURFACE STATION 121 FOR USAGE GROUP 3

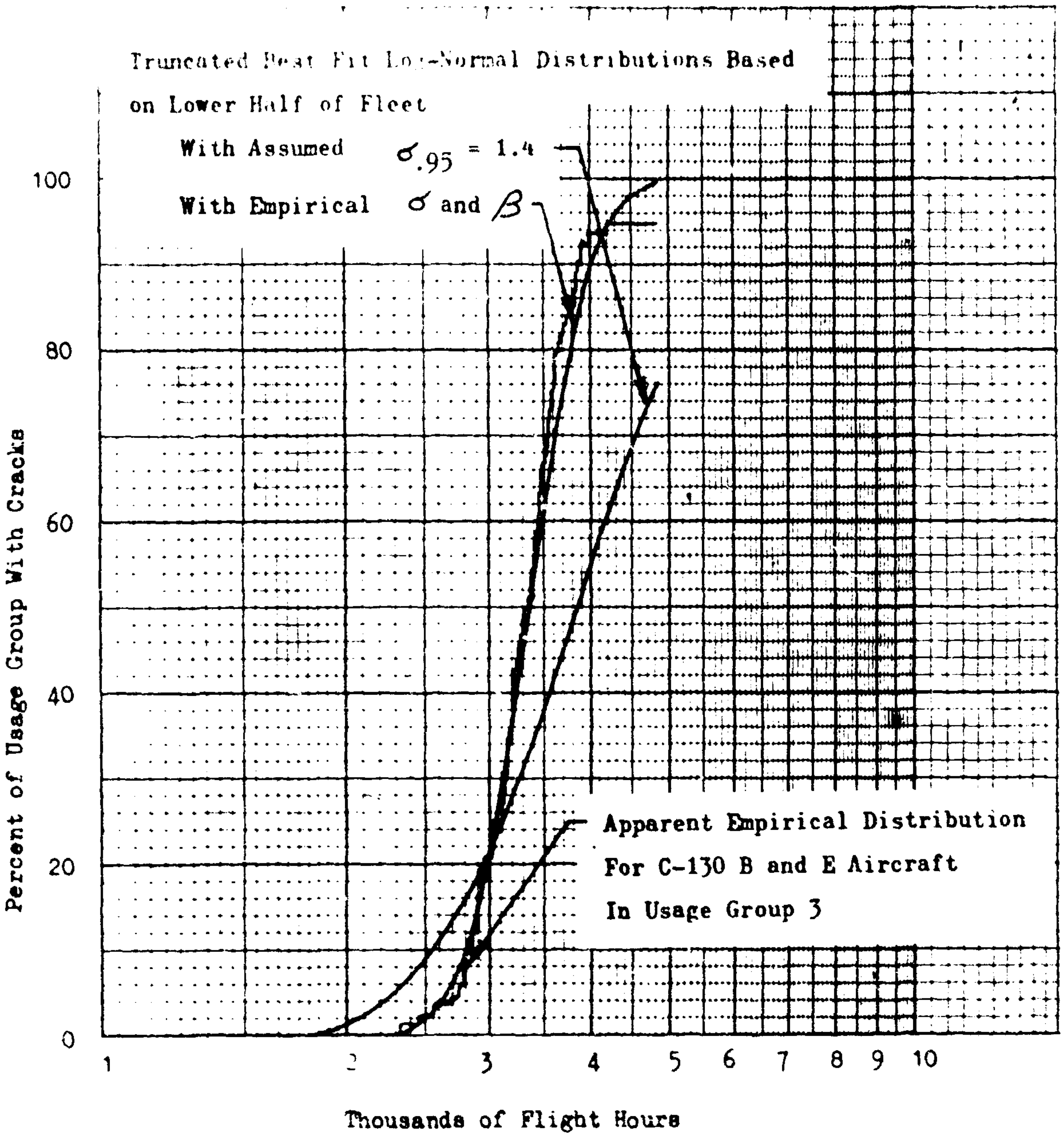


FIGURE 67 APPARENT AND TRUNCATED BEST FIT LOG-NORMAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING LOWER SURFACE STATION 121 FOR USAGE GROUP 3

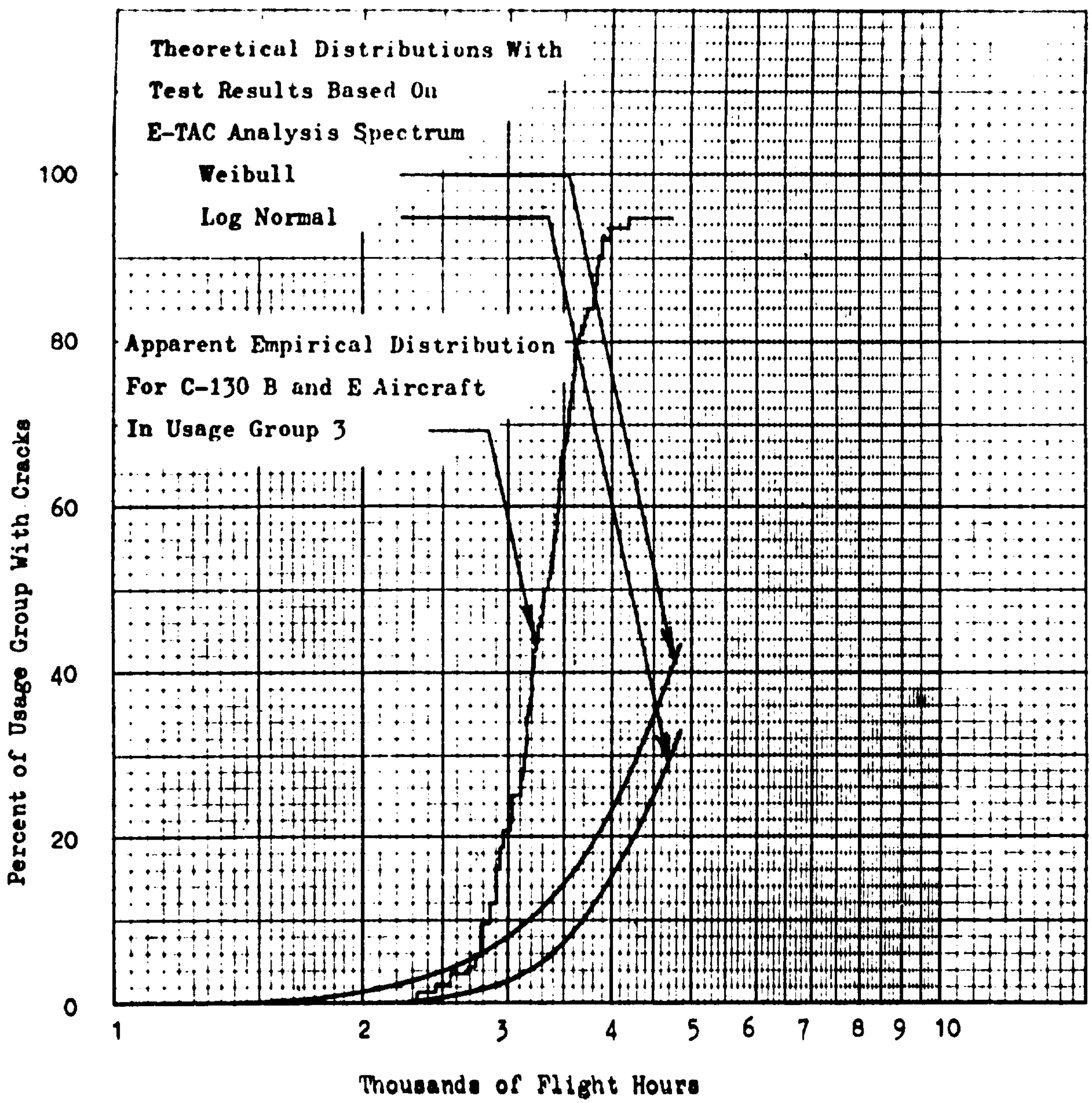


FIGURE 68 APPARENT AND THEORETICAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING LOWER SURFACE STATION 121 FOR USAGE GROUP 3

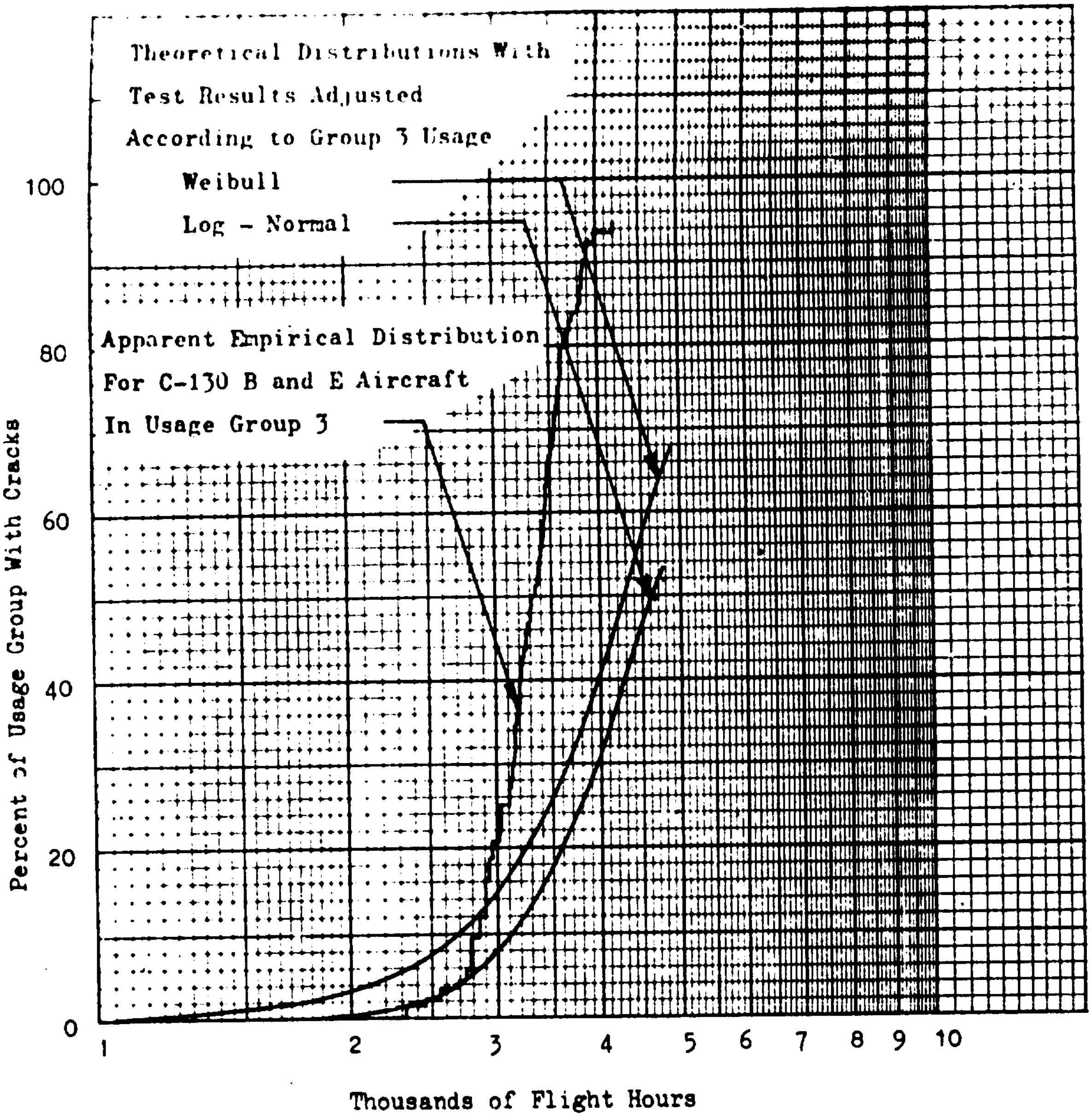


FIGURE 69 THEORETICAL DISTRIBUTION OF PROBABILITY OF TIME TO CRACK INITIATION ADJUSTED FOR GROUP 3 USAGE FOR CENTER WING LOWER SURFACE STATION 121

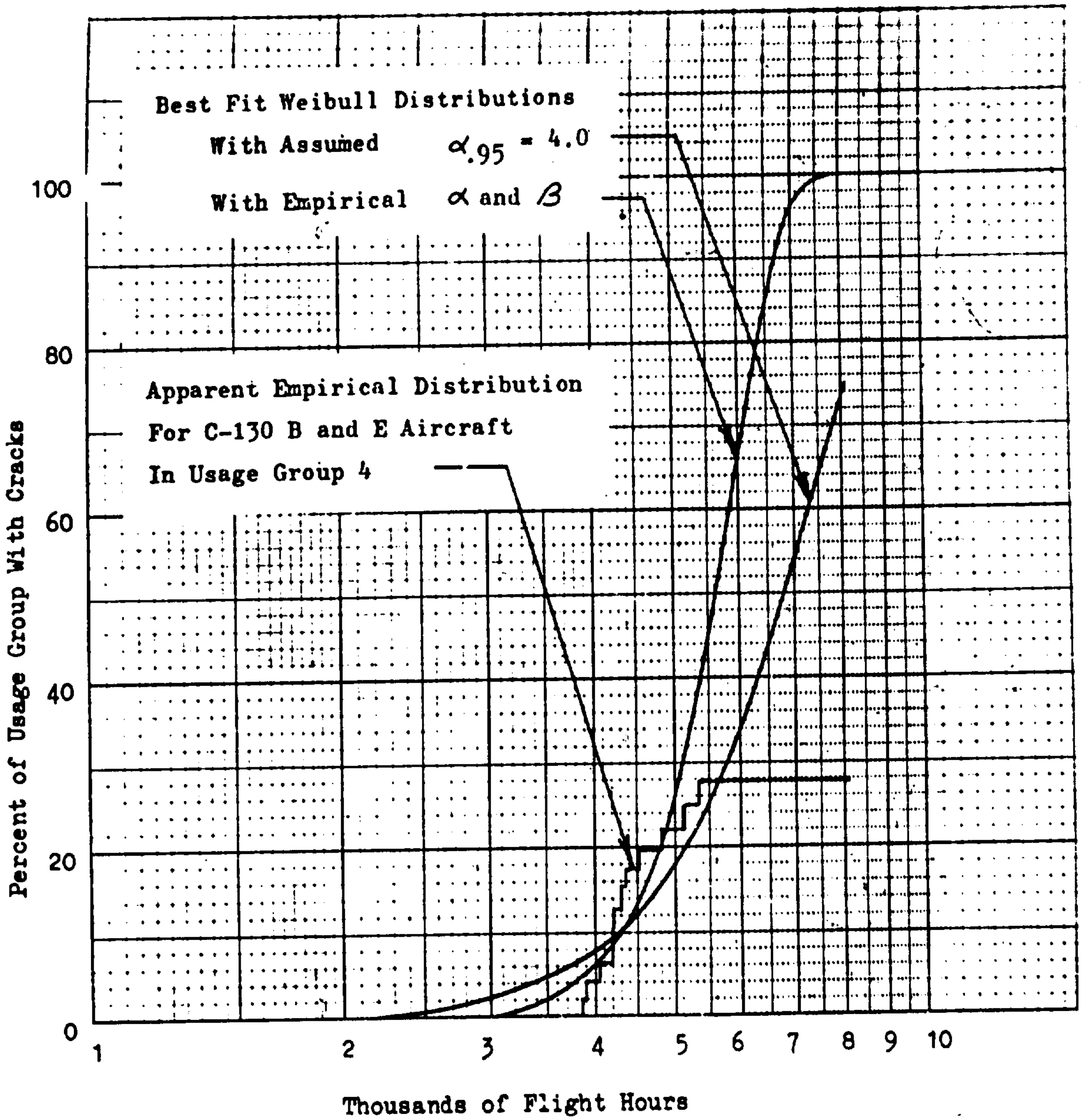


FIGURE 70 APPARENT AND BEST FIT WEIBULL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 38 FOR USAGE GROUP 4

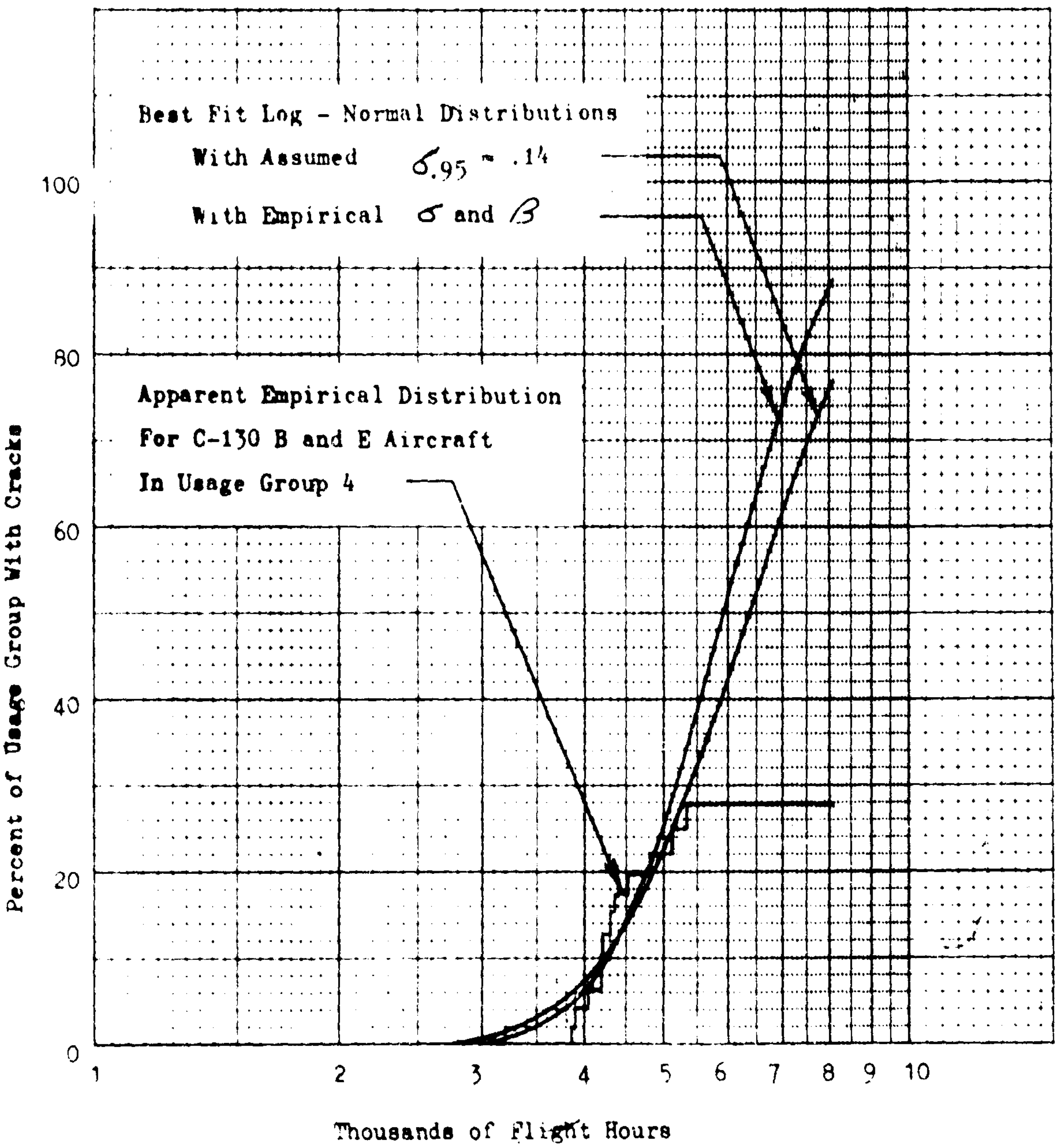


FIGURE 71 APPARENT AND BEST FIT LOG-NORMAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT CENTER WING UPPER SURFACE STATION 38 FOR USAGE GROUP 4

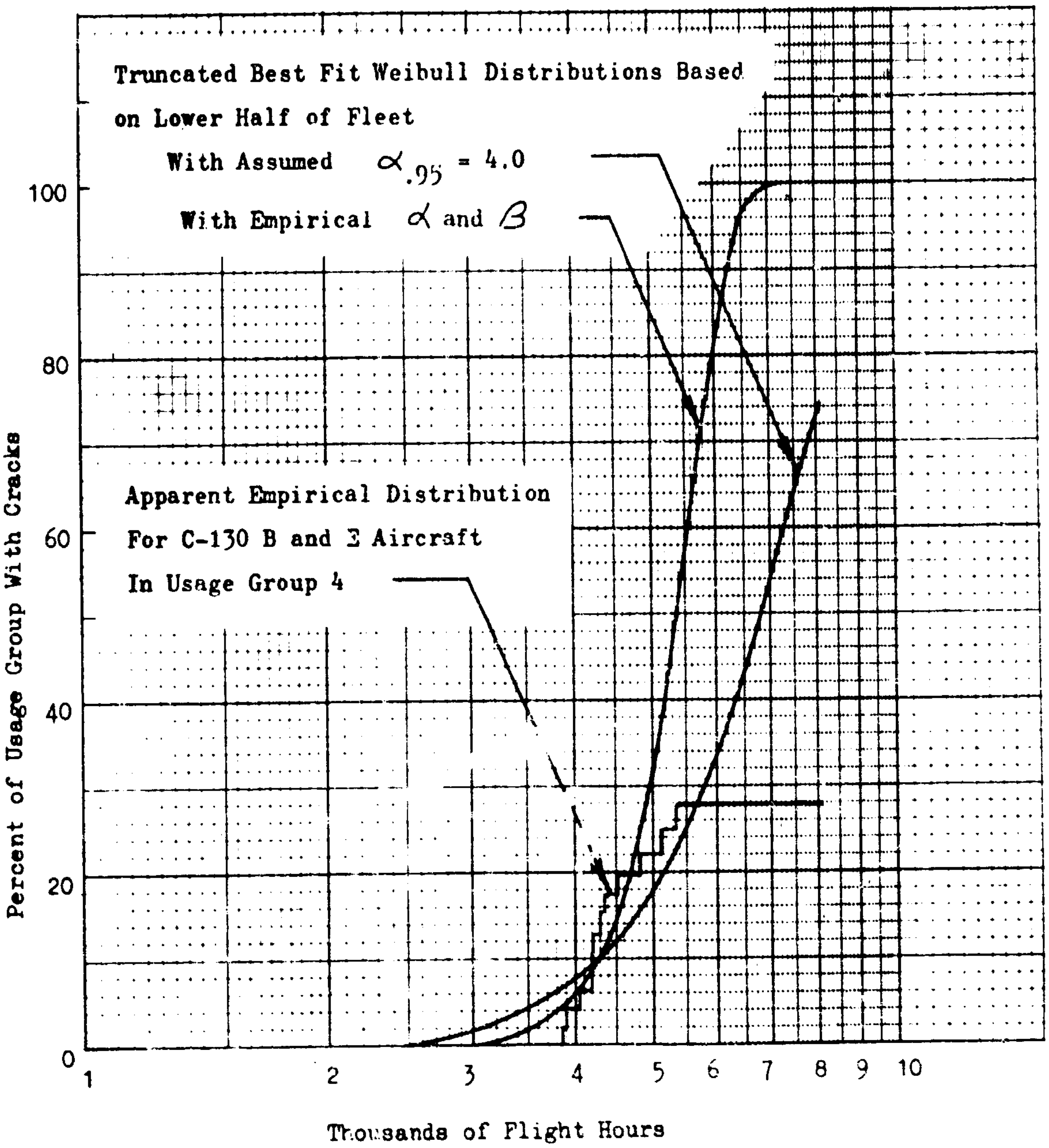


FIGURE 72 APPARENT AND TRUNCATED BEST FIT WEIBULL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 38 FOR USAGE GROUP 4

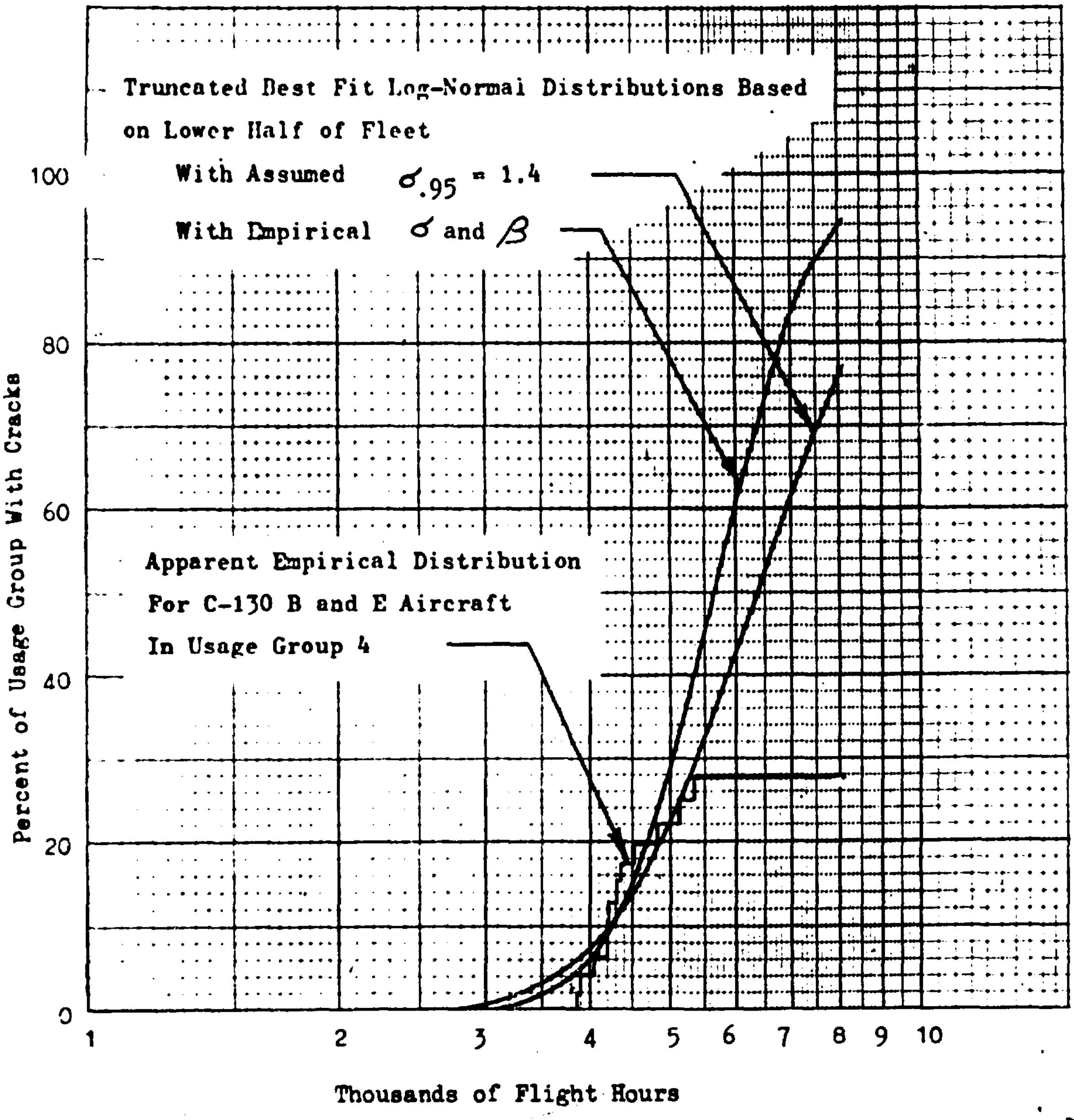


FIGURE 73 APPARENT AND TRUNCATED BEST FIT LOG-NORMAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 38 FOR USAGE GROUP 4

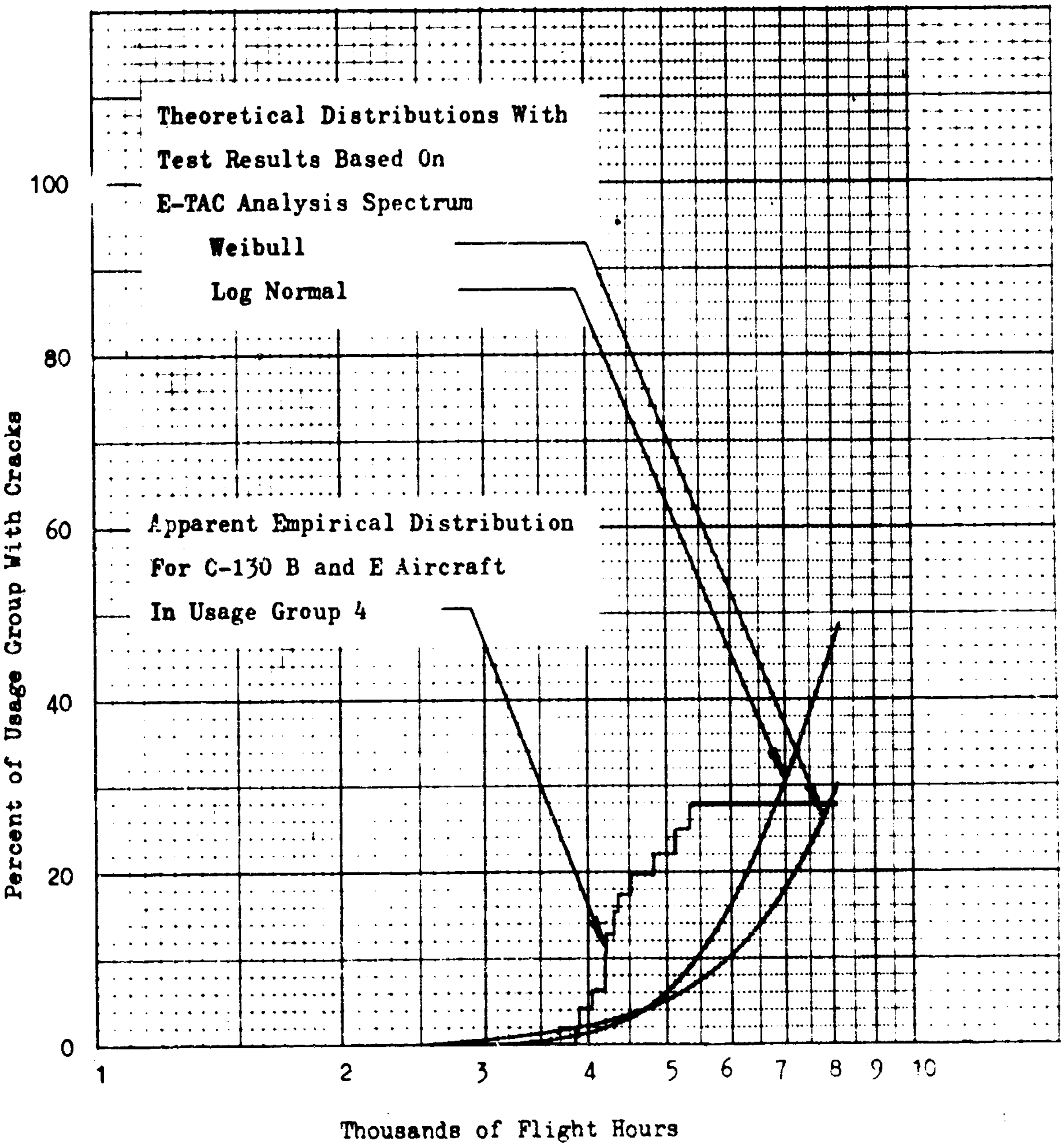


FIGURE 74 APPARENT AND THEORETICAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 38 FOR USAGE GROUP 4

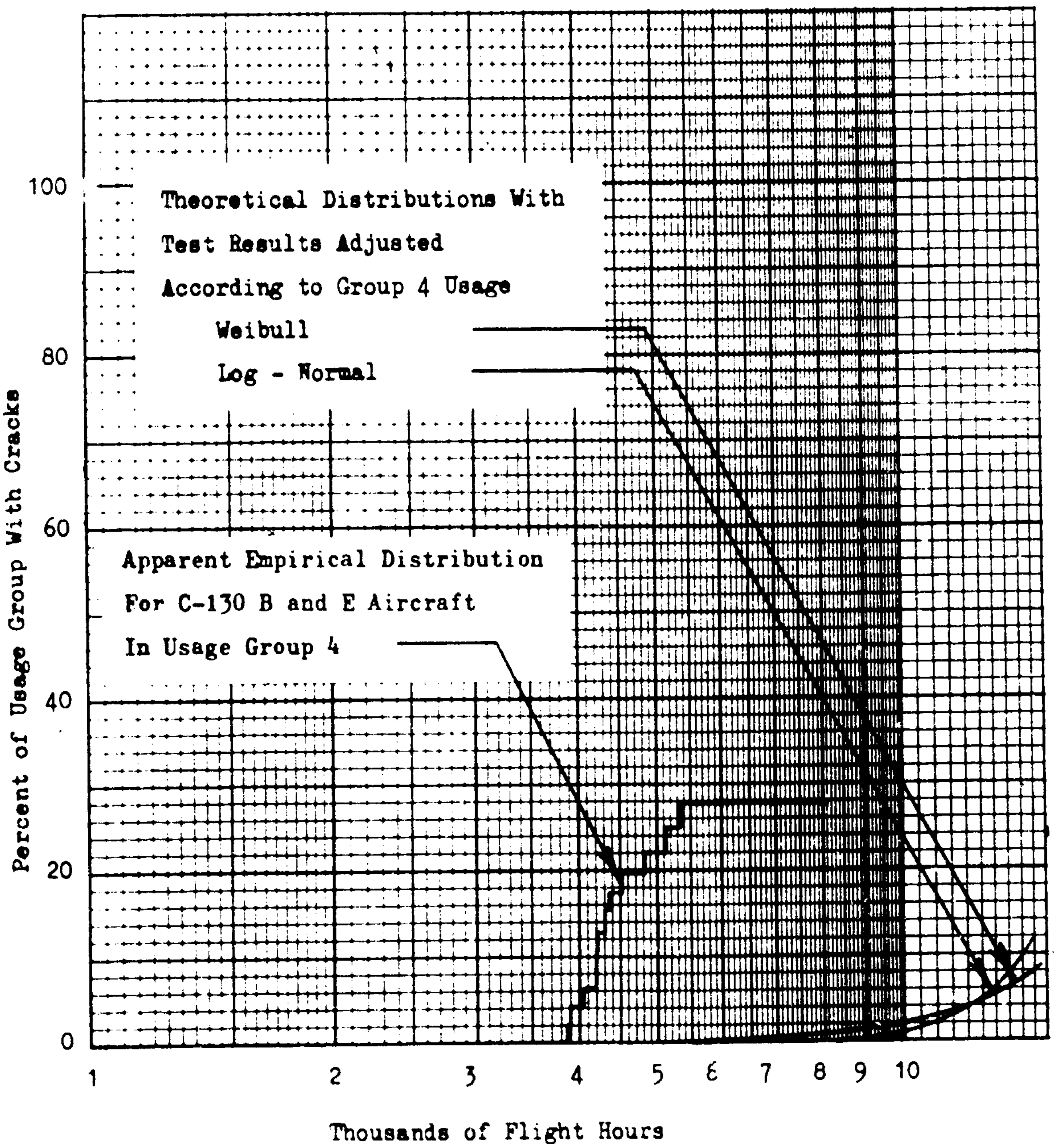


FIGURE 75 THEORETICAL DISTRIBUTION OF PROBABILITY OF TIME TO CRACK INITIATION ADJUSTED FOR GROUP 4 USAGE FOR CENTER WING UPPER SURFACE STATION 38

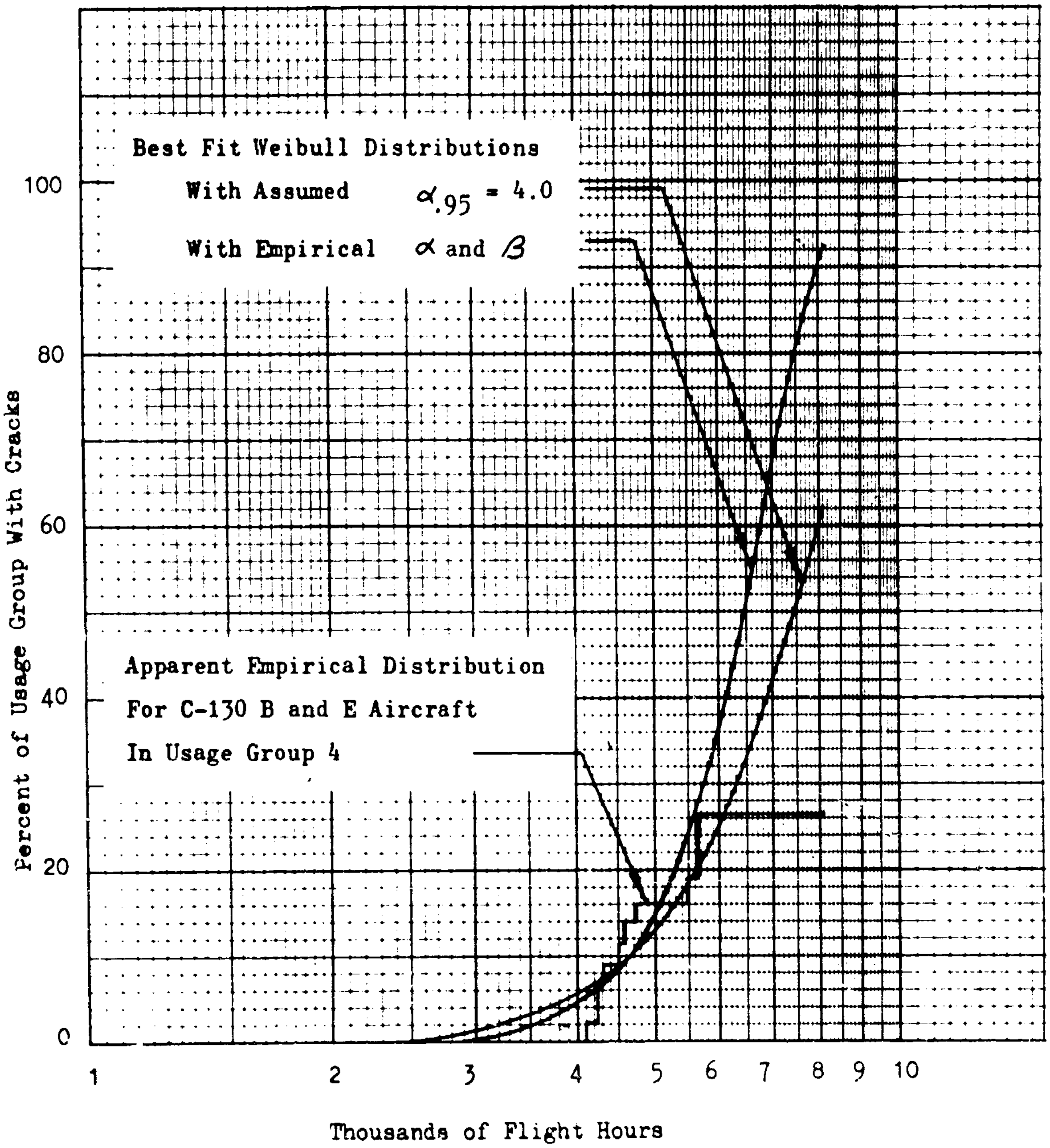


FIGURE 76 APPARENT AND BEST FIT WEIBULL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 105 FOR USAGE GROUP 4

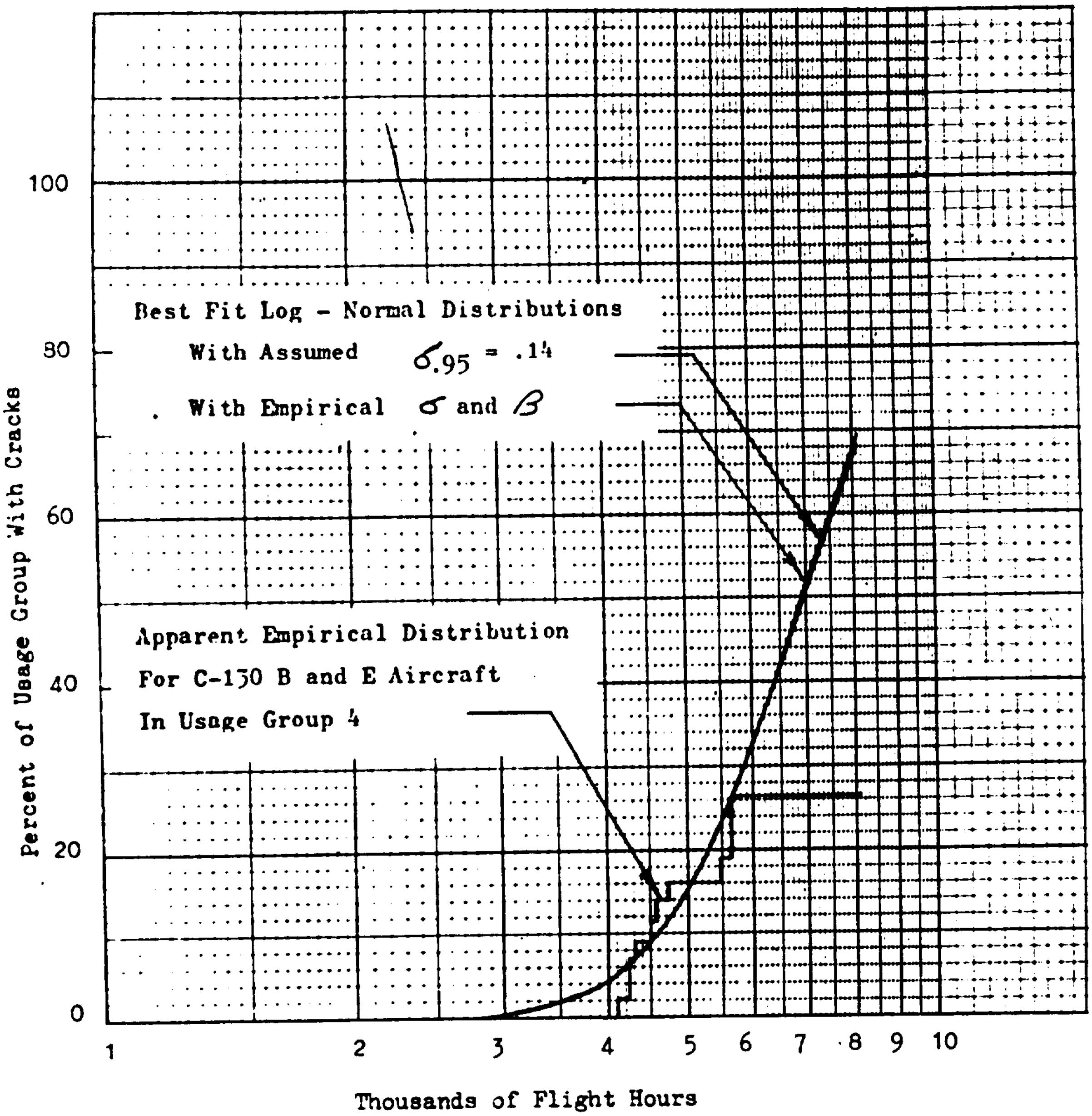


FIGURE 77 APPARENT AND BEST FIT LOG-NORMAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 103 FOR USAGE GROUP 4

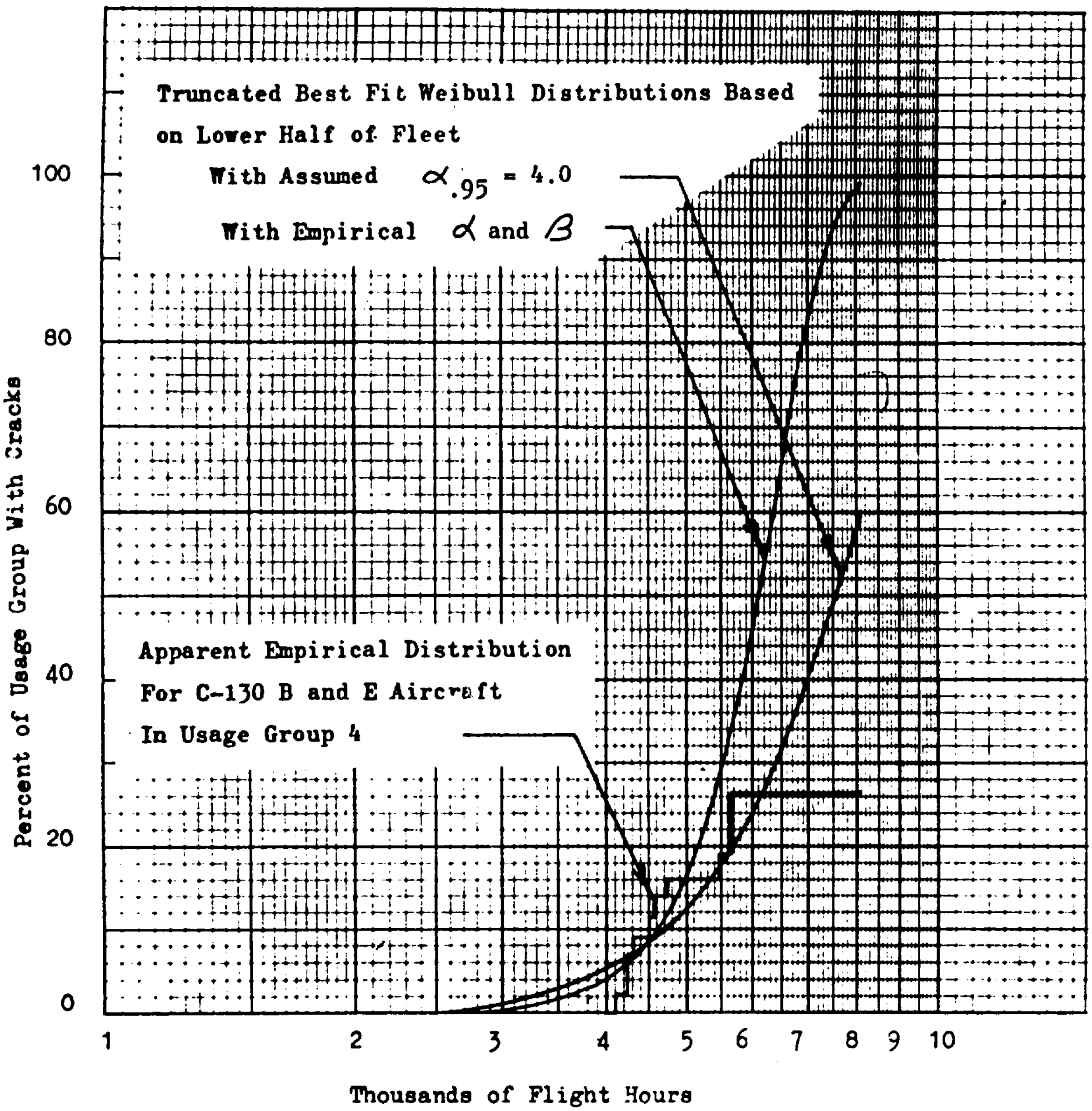


FIGURE 78 APPARENT AND TRUNCATED BEST FIT WEIBULL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 105 FOR USAGE GROUP 4

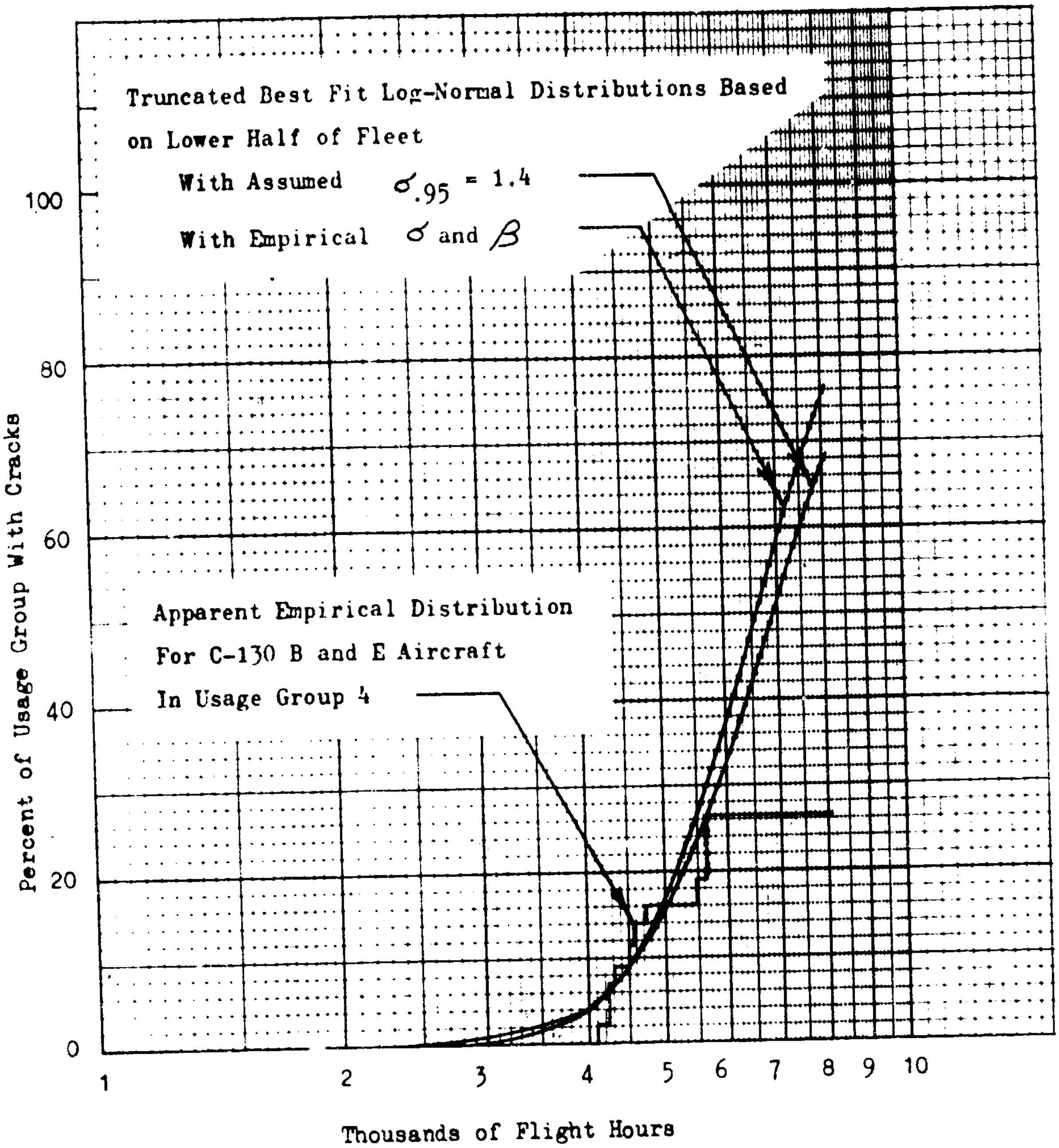


FIGURE 79 APPARENT AND BEST FIT TRUNCATED LOG-NORMAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT CENTER WING UPPER SURFACE STATION 105 FOR USAGE GROUP 4

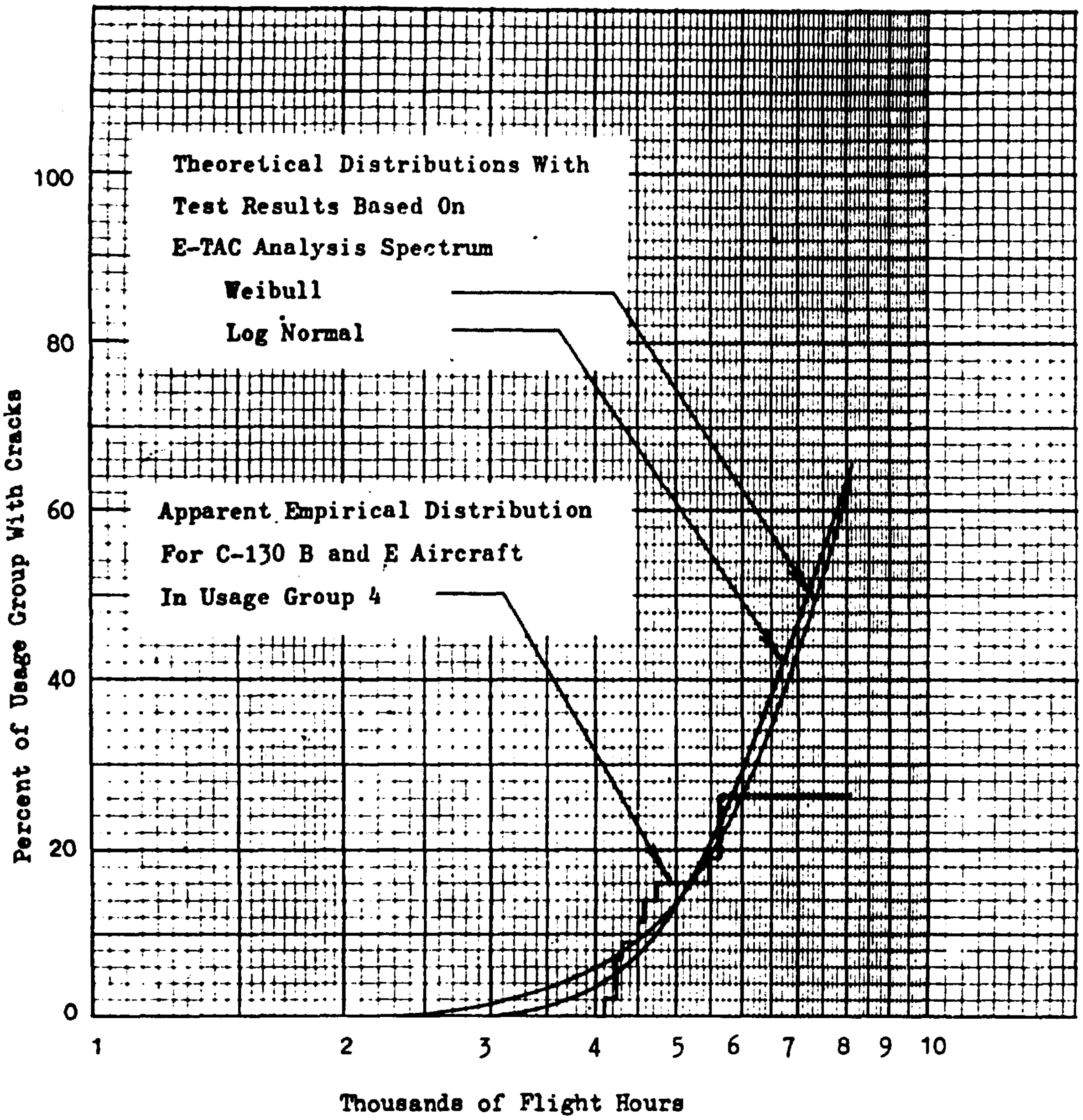


FIGURE 80 APPARENT AND THEORETICAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING UPPER SURFACE STATION 105 FOR USAGE GROUP 4

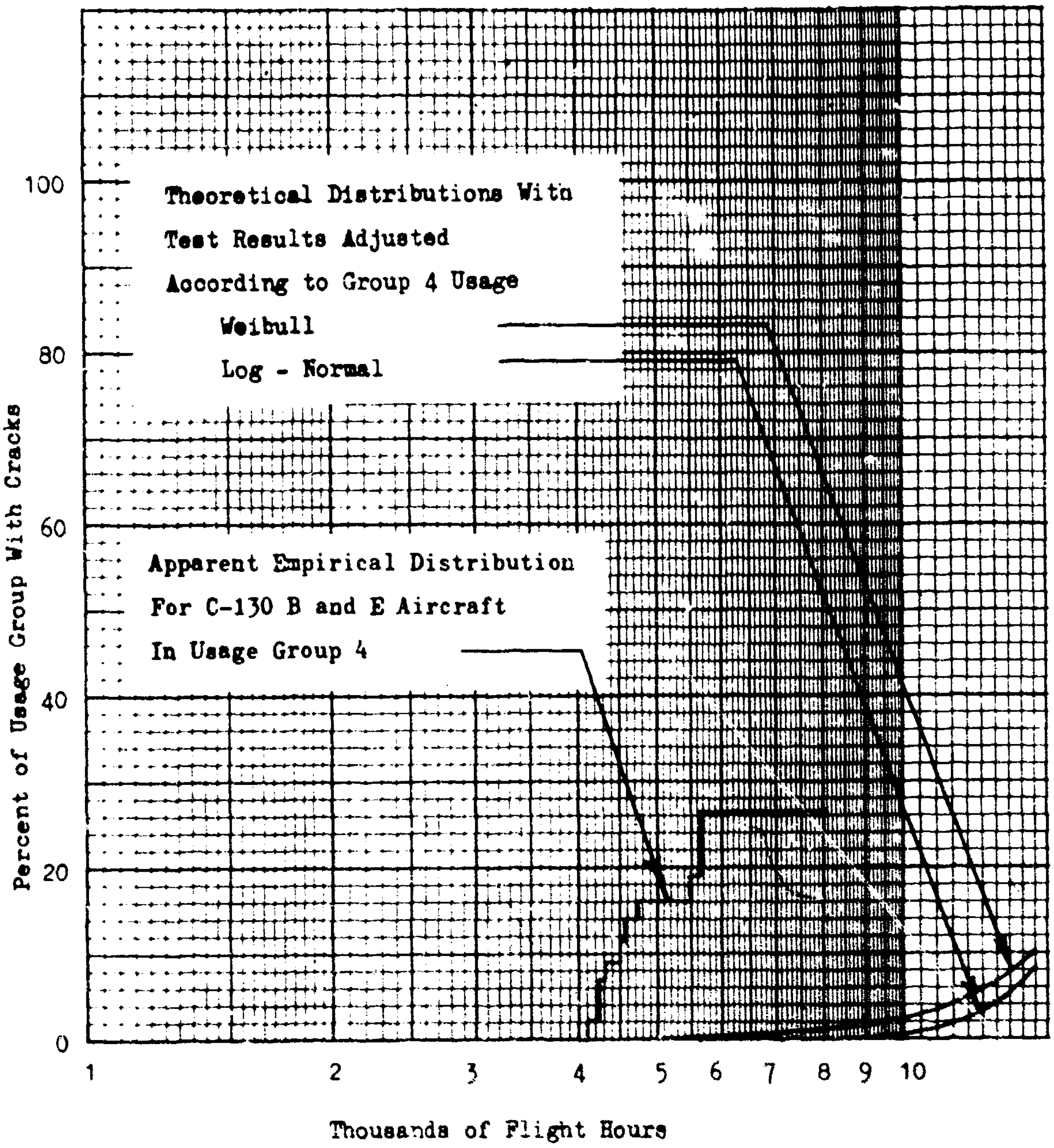


FIGURE 81 THEORETICAL DISTRIBUTION OF PROBABILITY OF TIME TO CRACK INITIATION ADJUSTED FOR GROUP 4 USAGE FOR CENTER WING UPPER SURFACE STATION 105

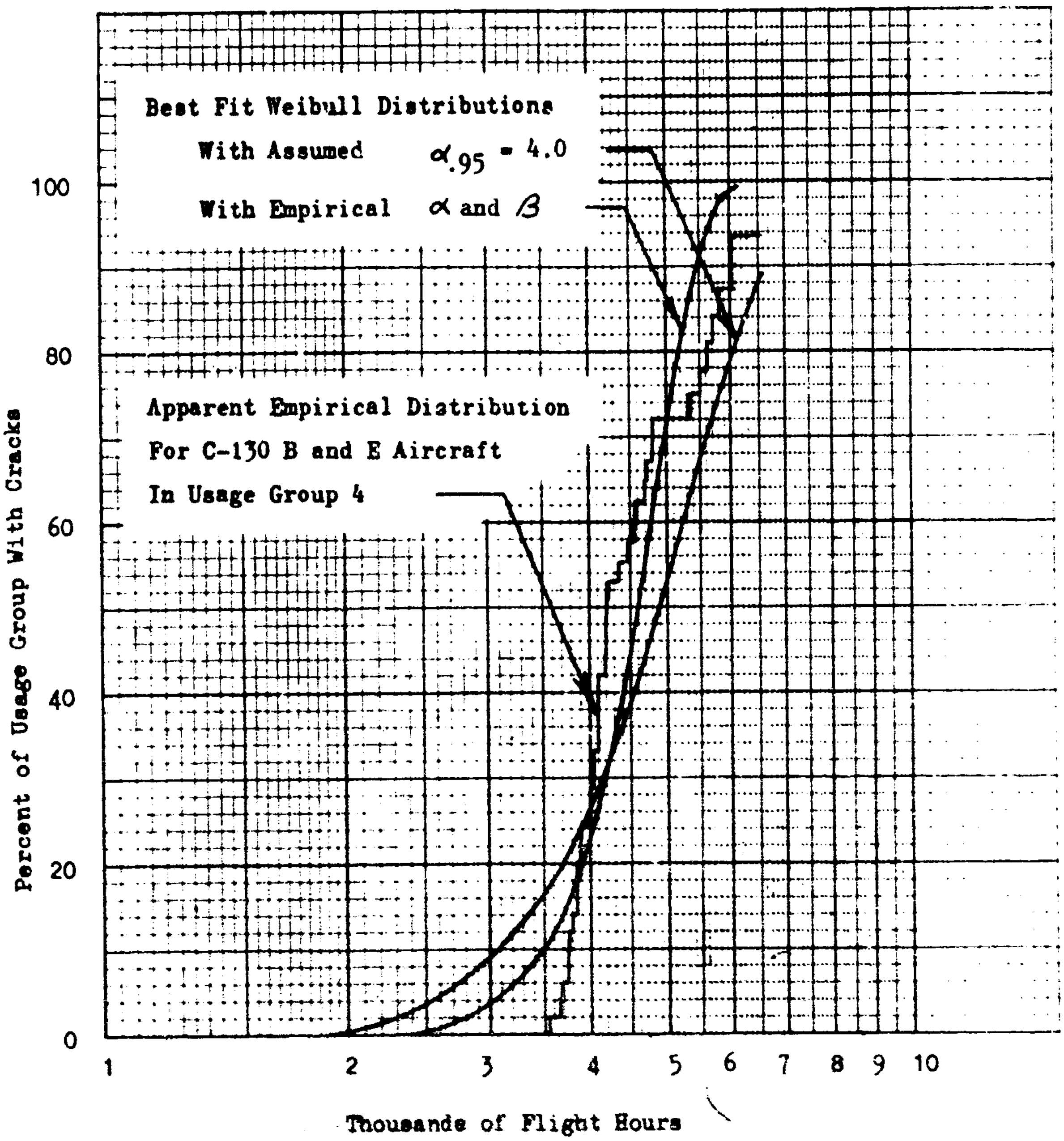


FIGURE 82 APPARENT AND BEST FIT WEIBULL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING LOWER SURFACE STATION 121 FOR USAGE GROUP 4

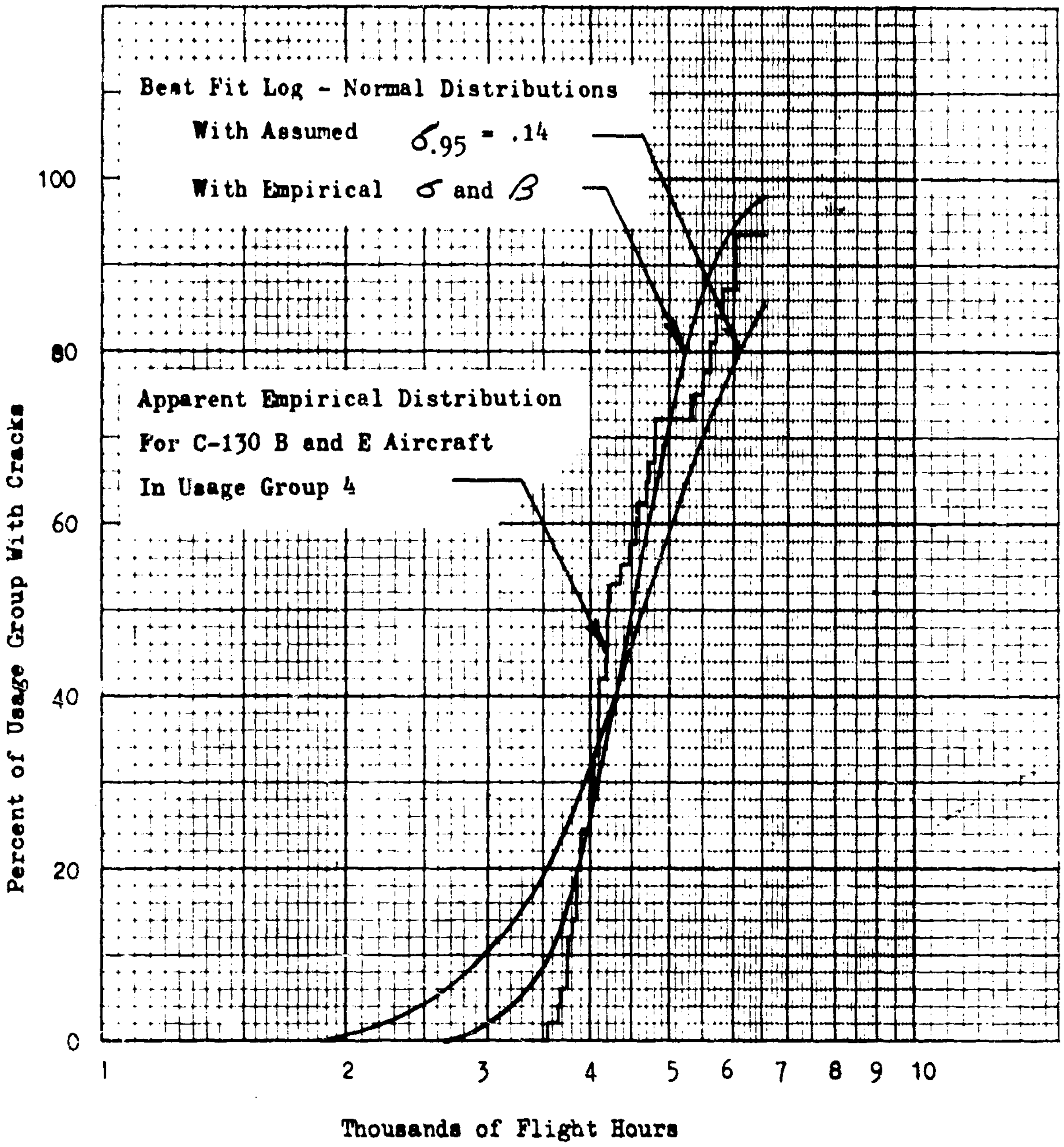


FIGURE 83 APPARENT AND BEST FIT LOG-NORMAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING LOWER SURFACE STATION 121 FOR USAGE GROUP 4

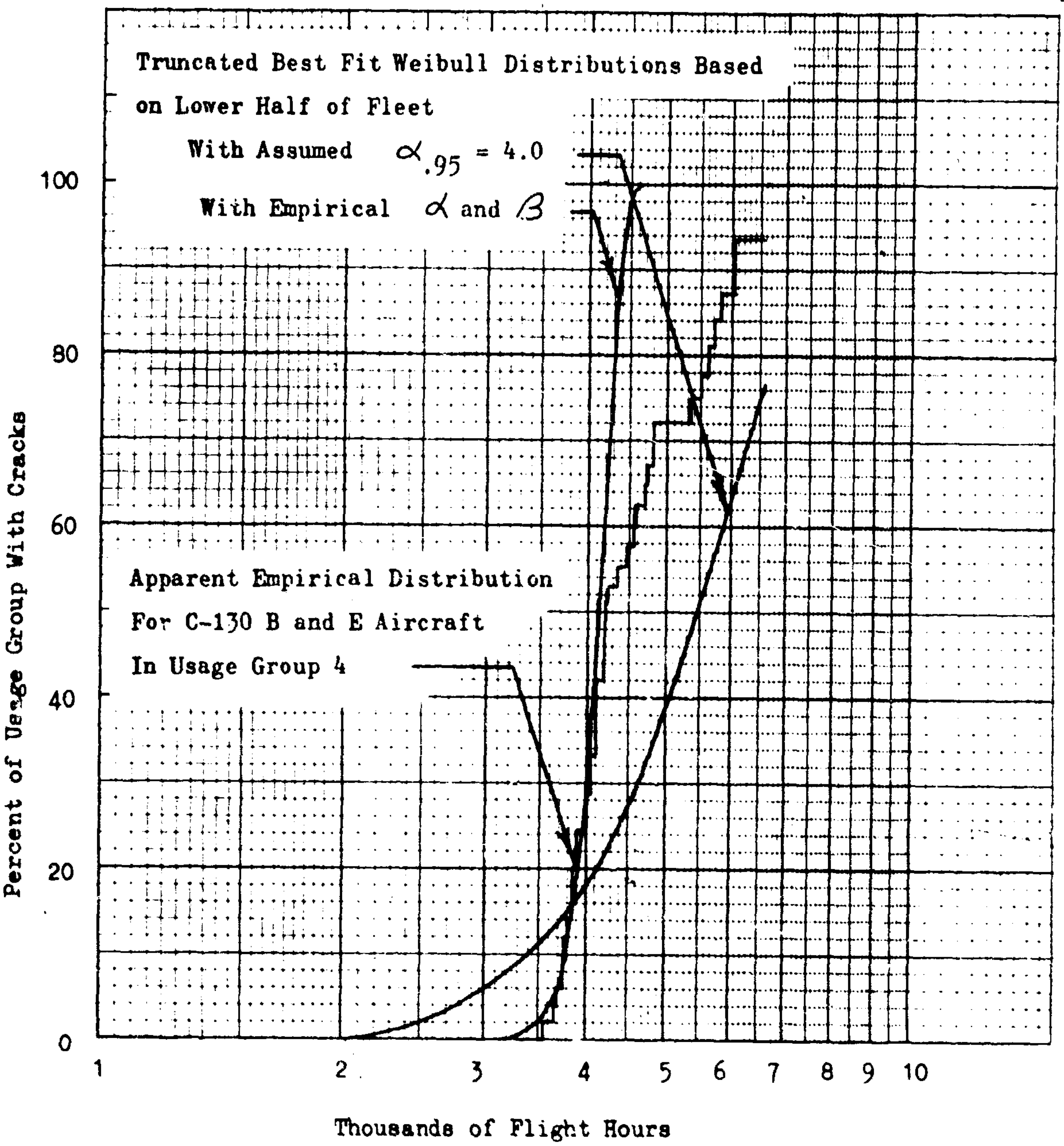


FIGURE 84 APPARENT AND TRUNCATED BEST FIT WEIBULL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING LOWER SURFACE STATION 121 FOR USAGE GROUP 4

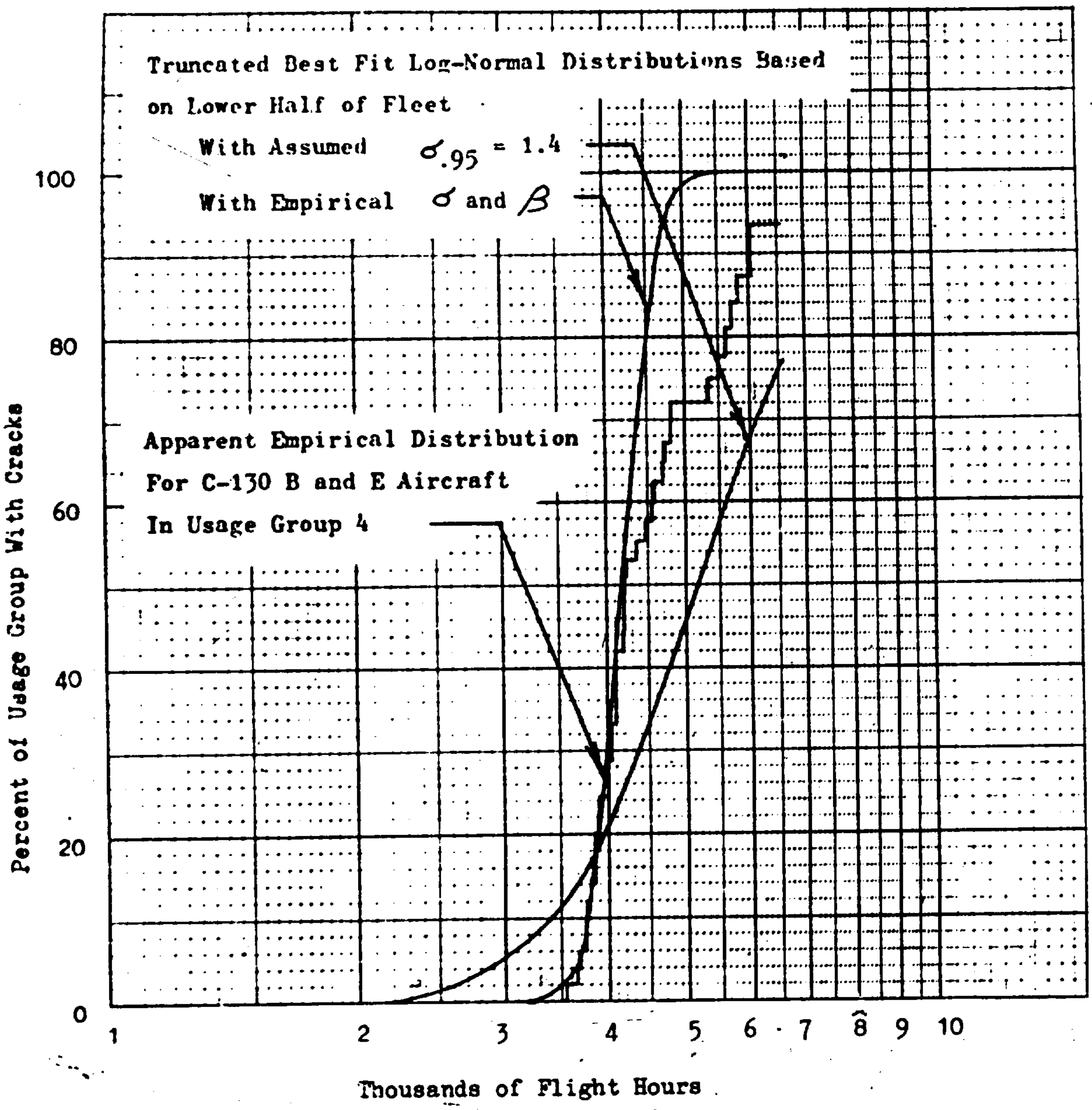


FIGURE 85 APPARENT AND TRUNCATED BEST FIT LOG NORMAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING LOWER SURFACE STATION 121 FOR USAGE GROUP 4

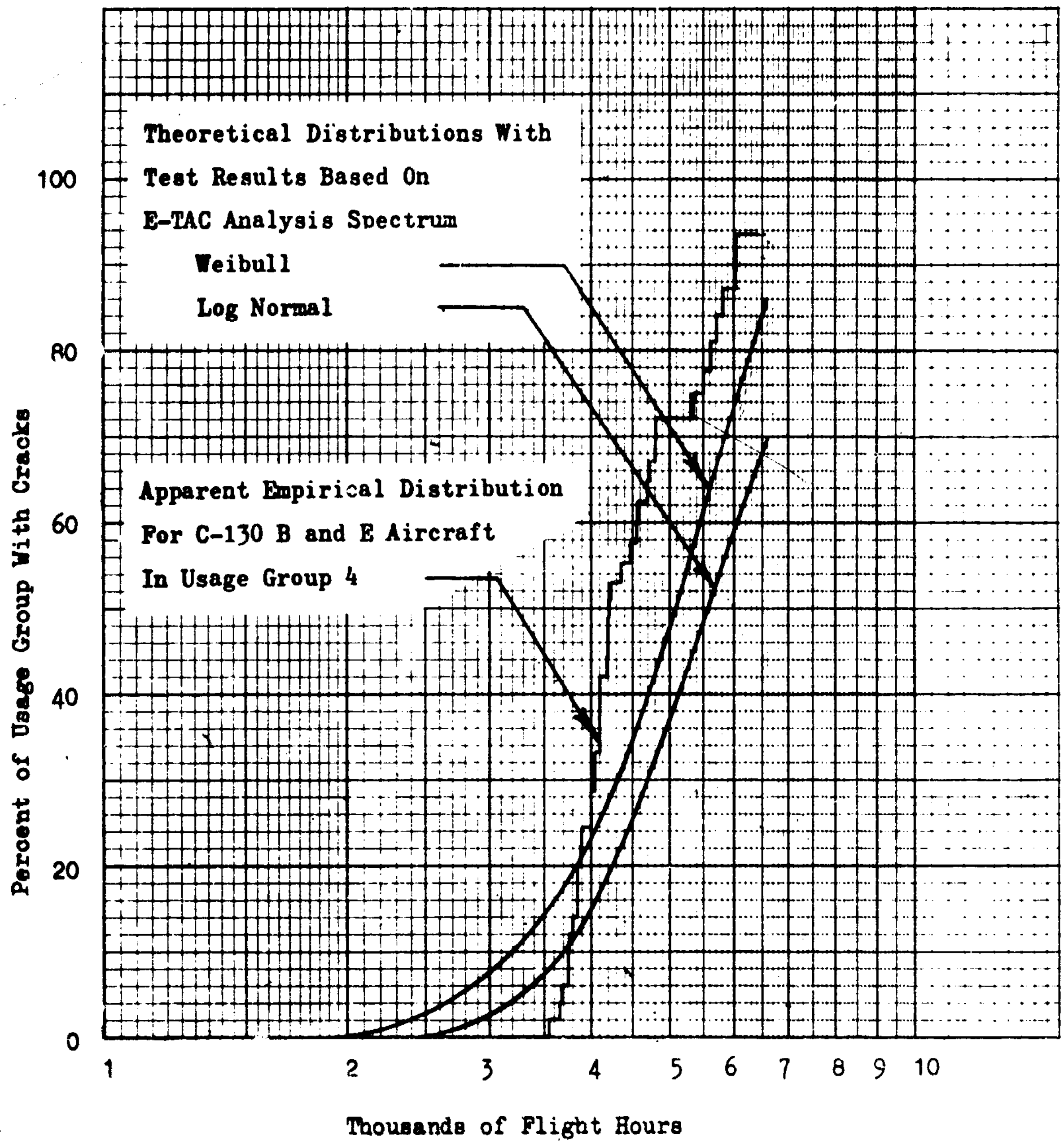


FIGURE 86 APPARENT AND THEORETICAL PROBABILITY DISTRIBUTIONS OF TIME TO CRACK INITIATION AT C-130 CENTER WING LOWER SURFACE STATION 121 FOR USAGE GROUP 4

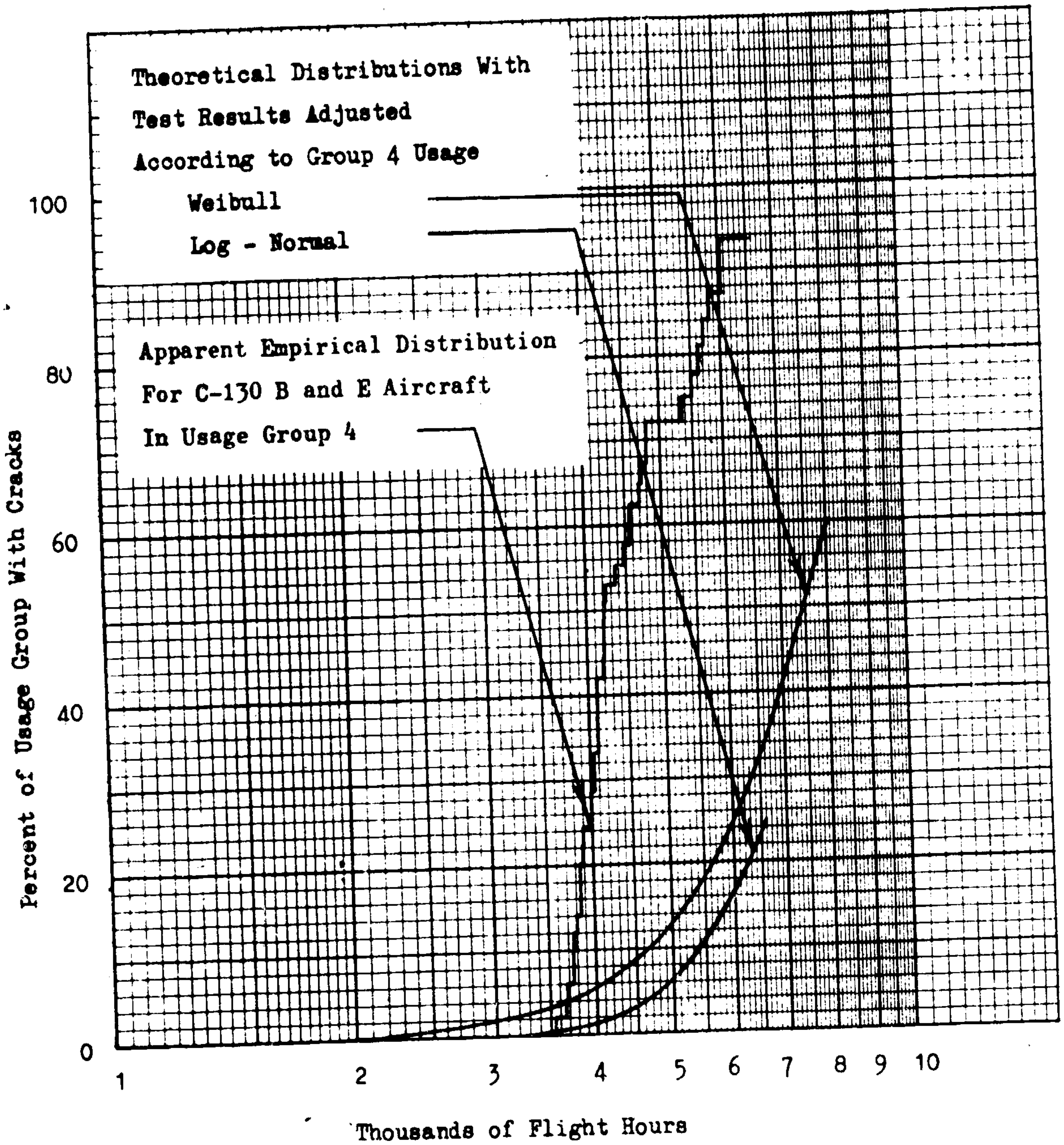


FIGURE 87 THEORETICAL DISTRIBUTION OF TIME TO CRACK INITIATION ADJUSTED FOR GROUP 4 USAGE FOR CENTER WING LOWER SURFACE STATION 121

APPENDIX

Generalized Relations for Scatter Factor Distribution

This section derives a general relation for determining distributions that can be used in selecting a scatter factor. The relation is derived in a most general form. Then it is used in the construction of scatter factor distributions.

Assumptions: Consider an experiment $\mathcal{J}$ which has an outcome that can be described with the random variable T with the distribution function $F\left(\frac{T}{\beta}\right)$, where β is known as a "scale" factor. Also consider two independent trials, A and $\mathcal{B}$, with the following descriptions.

A: Experiment $\mathcal{J}$ is performed n times, resulting in the set of values for T, $\left\{T_i / i = 1, \ldots n\right\}$. The outcome is described by the random variable

$$\bar{T} = \beta\, G_A \left\{ \frac{T_i}{\beta},\ i = 1, \ldots . n \right\} .$$

B: Experiment $\mathcal{J}$ is performed N times resulting in the set of values for T, $\left\{ t_i / i = 1 \ldots N \right\}$. The outcome is described by the random variable

$$\hat{t} = \beta\, G \left\{ \frac{t_i}{\beta},\ i = 1 \ldots N \right\}$$

Problem: Give steps for determining the distribution of the ratio

$$S = \frac{\bar{T}}{\hat{t}}$$

and show that this distribution is independent of β.

Solution: The distribution of $\bar{T}$ is determined by

$$P\left[\bar{T} < \bar{T}'\right] = \int_H \prod_{i=1}^{n} \frac{dF\left(\frac{T_i}{\beta}\right)}{dT_i}\, dT_i = \int_H \prod_{i=1}^{n} \frac{dF(u_i)}{du_i}\, du_i$$

where $u_i = \frac{T_i}{\beta}$ and H = region such that

$$\beta\, G_A \left\{ u_i,\ i = 1, \ldots n \right\} < \bar{\bar{T}}' .$$

Note that region H is the same as the region where

$$G_A \left\{ u_i,\ i = 1, \ldots n \right\} < \frac{\bar{\bar{T}}'}{\beta} .$$

Thus the distribution for $\bar{\bar{T}}$ can be described with an equation of the form

$$R\left(\frac{\bar{\bar{T}}}{\beta}\right) .$$

Similarly, the distribution for $\hat{t}$ will fit the form

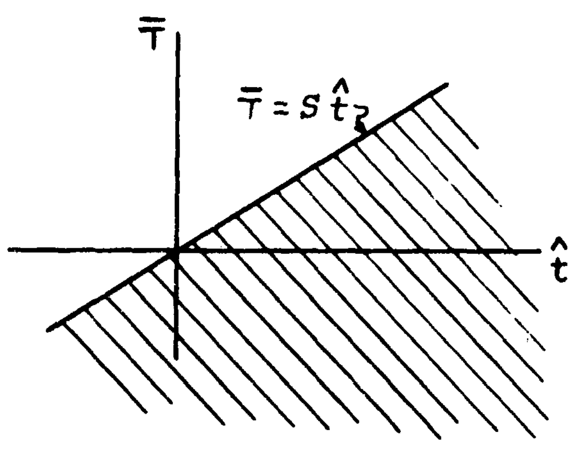
$$Q\left(\frac{\hat{t}}{\beta}\right) .$$

The distribution for S is as follows

$$V(S) = \int_H \frac{dQ\left(\frac{\hat{t}}{\beta}\right)}{d\hat{t}} \frac{dR\left(\frac{\bar{\bar{T}}}{\beta}\right)}{d\bar{\bar{T}}} d\bar{\bar{T}}\, d\hat{t} = \int_H \frac{dQ(u)}{du} \frac{dR(v)}{dv} dv du,$$

where H = region in which $\frac{\bar{\bar{T}}}{\hat{t}} < S$.

This region is shown below



Thus

$$V(S) = \int_{-\infty}^{\infty}\int_{-\infty}^{su} \frac{dQ(u)}{du} \frac{dR(v)}{dv} \, dv du$$

or

$$V(S) = \int_{-\infty}^{\infty} R(su) \frac{dQ(u)}{du} \, du$$

This expression is independent of the scale factor β and will be used to determine the scatter factor distributions.

Weibull MLE Distributions

The estimate is

$$\hat{T} = \left\{ \frac{1}{n} \sum_{i=1}^{n} T_i^{\alpha} \right\}^{\frac{1}{\alpha}} = \beta \left\{ \frac{1}{n} \sum_{i=1}^{n} v_i \right\}^{\frac{1}{\alpha}} = \beta \, u^{\frac{1}{\alpha}},$$

where $v_i = \left(\frac{T_i}{\beta} \right)^{\alpha}$ and $u = \left(\frac{\hat{T}}{\beta} \right)^{\alpha}$

The Weibull distribution for each variable T_i becomes

$$F(v_i) = 1 - e^{-v_i} \quad ; \quad f(v_i) = \frac{dF(v_i)}{dv_i} = e^{-v_i}$$

The distribution of the estimate is expressible as

$$R_n(u) = \int_R \prod_{i=1}^{n} f(v_i) \, dv_i$$

where R = region where the estimate $\left(\frac{\hat{T}}{\beta} \right)^{\alpha} < u$

These will be derived for n = 1, 2, 3

For n = 1

$$R_1(u) = \int_0^u f(v_1) \, dv_1 = F(u)$$

In the following calculations, note that f(a) f(b) = f(a+b).

For n = 2

$$R_2(u) = \int_0^u \int_0^{u-w_2} f(w_1)\, f(w_2)\, dw_1\, dw_2$$

$$= \int_0^u F(u - W_2)\, f(W_2)\, d W_2$$

$$= \int_0^u \left[1 - f(u - W_2)\right] f(W_2)\, d W_2$$

$$= \int_0^u \left[f(W_2) - f(u)\right] d W_2$$

$$R_2(u) = F(u) - u f(u)$$

For n = 3

$$R_3(u) = \int_0^u \int_0^{u-w_3} \int_0^{u-w_2-w_3} f(w_1)\, f(W_2)\, f(W_3)$$

$$dw_1\, dw_2\, dw_3$$

$$= \int_0^u f(W_3)\, R_2(u - W_3)\, dW_3$$

$$= \int_0^u \left[F(u - W_3) - (u - W_3)\, f(u - W_3)\right] f(W_3)\, dW_3$$

$$= \int_0^u F(u - W_3)\, f(W_3)\, dW_3$$

$$- \int_0^u (u - W_3)\, f(u)\, d W_3$$

$$R_3(u) = R_2(u) - \left(u^2 - \frac{u^2}{2}\right) f(u)$$

$$= F(u) - u\, f(u) - \frac{u^2}{2} f(u)$$

$$R_3(u) = F(u) - \left[1 + \frac{u}{2}\right] u\, f(u)$$

Distributions of First and Second Failures with Weibull Parent Distribution

Weibull Distribution

$$F(u) = 1 - e^{-u} \qquad \text{where} \qquad u = \left(\frac{T}{\beta}\right)^{\alpha}$$

1st Failure of N specimens

$$Q_1(u) = 1 - \left[1 - F(u)\right]^N = 1 - e^{-Nu}$$
$$= F(Nu) = 1 - f(Nu)$$

density function $$Q'(u) = N f(Nu) = N e^{-Nu}$$

2nd Failure of N specimens

$$Q_2(u) = 1 - \left[1 - F(u)\right]^N - \frac{N!}{(N-1)!}\left[1 - F(u)\right]^{N-1} F(u)$$

$$= 1 - e^{-Nu} - N e^{-(N-1)u}\left[1 - e^{-u}\right]$$

$$= 1 - f(Nu) - N f([N-1]u) + N f(Nu)$$

$$Q_2(u) = 1 + (N-1) f(Nu) - N f([N-1]u)$$

Density function

$$Q_2'(u) = N(N-1)\left[f([N-1]u) - f(Nu)\right]$$

"Scatter Factor" Distributions

These are distributions for the ratio $S = \left(\frac{\bar{T}}{\hat{t}}\right)^{\alpha}$

Case I $\bar{T}$ = equivalent flight hours from one test point

$\hat{t}$ = 1st failure of N specimens

$$V_I(s) = \int_{-\infty}^{\infty} R_1(su)\, Q_1'(u)\, du$$

$$= \int_0^{\infty} F(su) N f(Nu)\, du = \int_0^{\infty} N[1 - f(su)]\, f(Nu)\, du$$

$$= \int_0^{\infty} [N f(Nu) - N f([N+S]u)]\, du$$

$$= \left[F(Nu) - \frac{N}{N+S} F([N+S]u)\right]_0^{\infty} = 1 - \frac{N}{N+S}$$

$$V_I(s) = \frac{S}{N+S}$$

Case II $\bar{T}$ = same as case I

$\hat{t}$ = 2nd failure of N specimens

$$V_{II}(s) = \int_{-\infty}^{\infty} R_1(su)\, Q_2'(u)\, du$$

$$= \int_0^{\infty} [1 - f(su)]\, N(N-1)\, [f([N-1]u) - f(Nu)]\, du$$

$$= N(N-1) \int_0^{\infty} [f([N-1]u) - f([N-1+S]u) - f(Nu) + f([N+S]u)\, du$$

$$V_{II}(s) = \frac{NS}{N-1+S} - \frac{(N-1)\,S}{N+S}$$

Case III $\overline{T} = \left[\frac{1}{2}\left(T_1^{\alpha} + T_2^{\alpha}\right)\right]^{1/\alpha}$ i.e. 2 test specimens

$\hat{t}$ = 1st failure of N specimens

$$V_{III}(s) = \int_{-\infty}^{\infty} R_2(su)\, Q_1'(u)\, du = \int_0^{\infty} \left[F(2su) - 2su\, f(2su)\right] du$$

$$= \int_0^{\infty} \left[1 - f(2su) - su\, f(2su)\right] N\, f(Nu)\, du$$

$$= N \int_0^{\infty} \left[f(Nu) - f([N+2s]) - 2su\, f([N+2s]\, u)\right] du$$

$$V_{III}(s) = N\left[\frac{1}{N} - \frac{1}{N+2s}\right] - N2s \int_0^{\infty} u\, e^{-(N+2s)u}\, du = \left(\frac{2s}{N+2s}\right)^2$$

Case IV $\overline{T}$ = same as case III

$\hat{t}$ = 2nd failure of N specimens

$$V_{IV}(s) = \int_{-\infty}^{\infty} R_2(su)\, Q_2'(u)\, du$$

$$= \int_0^{\infty} \left[1 - e^{-2su} - 2su\, e^{-2su}\right] N(N-1)\left[e^{-(N-1)u} - e^{-Nu}\right] du$$

$$= N(N-1) \int_0^{\infty} \left[e^{-(N-1)u} - e^{-(N-1+2s)u} - e^{-Nu} + e^{-(N+2s)u}\right] du$$

$$+ N(N-1)\, 2s \int_0^{\infty} \left[u\, e^{-(N+2s)u} - u\, e^{-(N-1+2s)u}\right] du$$

$$V_{IV}(s) = N\left(\frac{2s}{N-1+2s}\right)^2 - (N-1)\left(\frac{2s}{N+2s}\right)^2$$

Case V $\bar{\bar{T}} = \left[\frac{1}{3}\left(T_1^{\alpha} + T_2^{\alpha} + T_3^{\alpha}\right)\right]^{1/\alpha}$, i.e. 3 test specimens

$\hat{t}$ = 1st failure of N specimens

$$V_{V}(s) = \int_{-\infty}^{\infty} R_3(su)\, Q_1'(u)\, du = \int_0^{\infty}\left[1 - e^{-3su} - 3su\, e^{-3su} - \frac{9s^2u^2}{2} e^{-3su}\right] N e^{-Nu} du$$

$$= N\int_0^{\infty}\left[e^{-Nu} - e^{-(N+3s)u} - 3su\, e^{-(N+3s)u} - \frac{9s^2u^2}{2} e^{-(N+3s)u}\right] du$$

$$= N\left[\frac{1}{N} - \frac{1}{N+3s} - \frac{3s}{(N+3s)^2} - \frac{9s^2}{(N+3s)^3}\right]$$

$$V_{V}(s) = \left(\frac{3s}{(N+3s)^3}\right)^3$$

Case VI $\bar{\bar{T}}$ = same as case V

$\hat{t}$ = 2nd failure of N specimens

$$V_{VI}(s) = \int_{-\infty}^{\infty} R_3(su)\, Q_2'(u)\, du$$

$$= \int_{-\infty}^{\infty}\left[1 - e^{-3su} - 3su\, e^{-3su} - \frac{9s^2u^2}{2} e^{-3su}\right]$$

$$N(N-1)\left[e^{-(N-1)u} - e^{-Nu}\right] du$$

$$= N\left(\frac{3s}{N-1+3s}\right)^3 - (N-1)\left(\frac{3s}{N+3s}\right)^3$$

TABLE XXXXVIII

THEORETICAL EXACT DISTRIBUTION OF PROBABILITY OF SCATTER FACTOR FUNCTION FOR WEAKEST MEMBER OF FLEET

P(S)=(NT/(NA+NT*S))**NT

NT=1.0 TEST RESULTS

SCATTER FACTOR FUNCTION (S)	NUMBER OF AIRCRAFT INFLEET (NA)									
	5	10	25	50	100	200	300	400	500	1000
1.	0.167	0.091	0.038	0.020	0.010	0.005	0.003	0.002	0.002	0.001
5.	0.500	0.333	0.167	0.091	0.048	0.024	0.016	0.012	0.010	0.005
10.	0.667	0.500	0.286	0.167	0.091	0.048	0.032	0.024	0.020	0.010
20.	0.800	0.667	0.444	0.286	0.167	0.091	0.063	0.048	0.038	0.020
30.	0.857	0.750	0.545	0.375	0.231	0.130	0.091	0.070	0.057	0.029
40.	0.889	0.800	0.615	0.444	0.286	0.167	0.118	0.091	0.074	0.038
60.	0.923	0.857	0.706	0.545	0.375	0.231	0.167	0.130	0.107	0.057
80.	0.941	0.889	0.762	0.615	0.444	0.286	0.211	0.167	0.138	0.074
100.	0.952	0.909	0.800	0.667	0.500	0.333	0.250	0.200	0.167	0.091
150.	0.968	0.937	0.857	0.750	0.600	0.429	0.333	0.273	0.231	0.130
200.	0.976	0.952	0.889	0.800	0.667	0.500	0.400	0.333	0.286	0.167
300.	0.984	0.968	0.923	0.857	0.750	0.600	0.500	0.429	0.375	0.231
400.	0.988	0.976	0.941	0.889	0.800	0.667	0.571	0.500	0.444	0.286
600.	0.992	0.984	0.960	0.923	0.857	0.750	0.667	0.600	0.545	0.375
800.	0.994	0.988	0.970	0.941	0.889	0.800	0.727	0.667	0.615	0.444
1000.	0.995	0.990	0.976	0.952	0.909	0.833	0.769	0.714	0.667	0.500
2000.	0.998	0.995	0.988	0.976	0.952	0.909	0.870	0.833	0.800	0.667
3000.	0.998	0.997	0.992	0.984	0.968	0.937	0.909	0.882	0.857	0.750
4000.	0.999	0.998	0.994	0.988	0.976	0.952	0.930	0.909	0.889	0.800
5000.	0.999	0.998	0.995	0.990	0.980	0.962	0.943	0.926	0.909	0.833
6000.	0.999	0.998	0.996	0.992	0.984	0.968	0.952	0.938	0.923	0.857
7000.	0.999	0.999	0.996	0.993	0.986	0.972	0.959	0.946	0.933	0.875
8000.	0.999	0.999	0.997	0.994	0.988	0.976	0.964	0.952	0.941	0.889
9000.	0.999	0.999	0.997	0.994	0.989	0.978	0.968	0.957	0.947	0.900
10000.	1.000	0.999	0.998	0.995	0.990	0.980	0.971	0.962	0.952	0.909

TABLE XXXXVIII (CONTINUED)

THEORETICAL EXACT DISTRIBUTION OF PROBABILITY OF SCATTER FACTOR FUNCTION FOR WEAKEST MEMBER OF FLEET

P(S)=(NT/(NA+NT*S))**NT

NT=2.0 TEST RESULTS

SCATTER FACTOR FUNCTION (S)	NUMBER OF AIRCRAFT INFLEET (NA)									
	5	10	25	50	100	200	300	400	500	1000
1.	0.082	0.028	0.005	0.001	0.000	0.000	0.000	0.000	0.000	0.000
5.	0.444	0.250	0.082	0.028	0.008	0.002	0.001	0.001	0.000	0.000
10.	0.640	0.444	0.198	0.082	0.028	0.008	0.004	0.002	0.001	0.000
20.	0.790	0.640	0.379	0.198	0.082	0.028	0.014	0.008	0.005	0.001
30.	0.852	0.735	0.498	0.298	0.141	0.053	0.028	0.017	0.011	0.003
40.	0.886	0.790	0.580	0.379	0.198	0.082	0.044	0.028	0.019	0.005
60.	0.922	0.852	0.685	0.498	0.298	0.141	0.082	0.053	0.037	0.011
80.	0.940	0.886	0.748	0.580	0.379	0.198	0.121	0.082	0.059	0.019
100.	0.952	0.907	0.790	0.640	0.444	0.250	0.160	0.111	0.082	0.028
150.	0.967	0.937	0.852	0.735	0.562	0.360	0.250	0.184	0.141	0.053
200.	0.975	0.952	0.886	0.790	0.640	0.444	0.327	0.250	0.198	0.082
300.	0.984	0.967	0.922	0.852	0.735	0.562	0.444	0.360	0.298	0.141
400.	0.988	0.975	0.940	0.886	0.790	0.640	0.529	0.444	0.379	0.198
600.	0.992	0.984	0.960	0.922	0.852	0.735	0.640	0.563	0.498	0.298
800.	0.994	0.988	0.969	0.940	0.886	0.790	0.709	0.640	0.580	0.379
1000.	0.995	0.990	0.975	0.952	0.907	0.826	0.756	0.694	0.640	0.444
2000.	0.998	0.995	0.988	0.975	0.952	0.907	0.865	0.826	0.790	0.640
3000.	0.998	0.997	0.992	0.984	0.967	0.937	0.907	0.879	0.852	0.735
4000.	0.999	0.998	0.994	0.988	0.975	0.952	0.929	0.907	0.886	0.790
5000.	0.999	0.998	0.995	0.990	0.980	0.961	0.943	0.925	0.907	0.826
6000.	0.999	0.998	0.996	0.992	0.984	0.967	0.952	0.937	0.922	0.852
7000.	0.999	0.999	0.996	0.993	0.986	0.972	0.958	0.945	0.932	0.871
8000.	0.999	0.999	0.997	0.994	0.988	0.975	0.964	0.952	0.940	0.886
9000.	0.999	0.999	0.997	0.994	0.989	0.978	0.967	0.957	0.947	0.898
10000.	1.000	0.999	0.998	0.995	0.990	0.980	0.971	0.961	0.952	0.907

TABLE XXXXVIII (CONTINUED)

THEORETICAL EXACT DISTRIBUTION OF PROBABILITY OF SCATTER FACTOR FUNCTION FOR WEAKEST MEMBER OF FLEET

P(S)=(NT/(NA+NT*S))**NT

NT=3.0 TEST RESULTS

SCATTER FACTOR FUNCTION (S)	NUMBER OF AIRCRAFT INFLEET (NA)									
	5	10	25	50	100	200	300	400	500	1000
1.	0.053	0.012	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.	0.422	0.216	0.053	0.012	0.002	0.000	0.000	0.000	0.000	0.000
10.	0.630	0.422	0.162	0.053	0.012	0.002	0.001	0.000	0.000	0.000
20.	0.787	0.630	0.352	0.162	0.053	0.012	0.005	0.002	0.001	0.000
30.	0.850	0.729	0.479	0.266	0.106	0.030	0.012	0.006	0.004	0.001
40.	0.885	0.787	0.567	0.352	0.162	0.053	0.023	0.012	0.007	0.001
60.	0.921	0.850	0.677	0.479	0.266	0.106	0.053	0.030	0.019	0.004
80.	0.940	0.885	0.743	0.567	0.352	0.162	0.088	0.053	0.034	0.007
100.	0.952	0.906	0.787	0.630	0.422	0.216	0.125	0.079	0.053	0.012
150.	0.967	0.936	0.850	0.729	0.548	0.332	0.216	0.148	0.106	0.030
200.	0.975	0.952	0.885	0.787	0.630	0.422	0.296	0.216	0.162	0.053
300.	0.984	0.967	0.921	0.850	0.729	0.548	0.422	0.332	0.266	0.106
400.	0.988	0.975	0.940	0.885	0.787	0.630	0.512	0.422	0.352	0.162
600.	0.992	0.984	0.959	0.921	0.850	0.729	0.630	0.548	0.479	0.266
800.	0.994	0.988	0.969	0.940	0.885	0.787	0.702	0.630	0.567	0.352
1000.	0.995	0.990	0.975	0.952	0.906	0.824	0.751	0.687	0.630	0.422
2000.	0.998	0.995	0.988	0.975	0.952	0.906	0.864	0.824	0.787	0.630
3000.	0.998	0.997	0.992	0.984	0.967	0.936	0.906	0.878	0.850	0.729
4000.	0.999	0.998	0.994	0.988	0.975	0.952	0.929	0.906	0.885	0.787
5000.	0.999	0.998	0.995	0.990	0.980	0.961	0.942	0.924	0.906	0.824
6000.	0.999	0.998	0.996	0.992	0.984	0.967	0.952	0.935	0.921	0.850
7000.	0.999	0.999	0.996	0.993	0.986	0.972	0.958	0.945	0.932	0.870
8000.	0.999	0.999	0.997	0.994	0.988	0.975	0.963	0.952	0.940	0.885
9000.	0.999	0.999	0.997	0.994	0.989	0.978	0.967	0.957	0.946	0.897
10000.	0.999	0.999	0.998	0.995	0.990	0.980	0.971	0.961	0.952	0.906

TABLE XXXXIX

THEORETICAL EXACT DISTRIBUTION OF PROBABILITY OF SCATTER FACTOR FUNCTION FOR 2ND WEAKEST MEMBER OF FLEET

P(S)=NA*(NT*S/(NA+NT*S-1.))**NT-(NA-1.)*(NT*S/(NA+NT*S))**NT

NT=1.0 TEST RESULTS

SCATTER FACTOR FUNCTION (S)	NUMBER OF AIRCRAFT IN FLEET (NA)									
	5	10	25	50	100	200	300	400	500	1000
1.	0.333	0.182	0.077	0.039	0.020	0.010	0.007	0.005	0.004	0.002
5.	0.778	0.571	0.310	0.175	0.093	0.048	0.033	0.025	0.020	0.010
10.	0.905	0.76[illegible]	0.496	0.308	0.174	0.093	0.064	0.048	0.039	0.020
20.	0.967	0.897	0.697	0.493	0.307	0.174	0.121	0.093	0.076	0.039
30.	0.983	0.942	0.798	0.612	0.410	0.244	0.174	0.135	0.110	0.057
40.	0.990	0.963	0.856	0.694	0.491	0.306	0.222	0.174	0.143	0.075
60.	0.995	0.981	0.916	0.796	0.611	0.409	0.306	0.244	0.203	0.110
80.	0.997	0.989	0.945	0.854	0.693	0.490	0.377	0.306	0.257	0.143
100.	0.998	0.992	0.961	0.890	0.751	0.556	0.438	0.360	0.306	0.174
150.	0.999	0.996	0.980	0.938	0.841	0.674	0.556	0.471	0.409	0.244
200.	1.000	0.998	0.988	0.961	0.890	0.751	0.640	0.556	0.490	0.306
300.	1.000	0.999	0.994	0.980	0.938	0.840	0.750	0.674	0.610	0.408
400.	1.000	0.999	0.997	0.988	0.960	0.889	0.817	0.750	0.692	0.490
600.	1.000	1.000	0.998	0.994	0.980	0.938	0.889	0.840	0.794	0.610
800.	1.000	1.000	0.999	0.997	0.988	0.960	0.926	0.889	0.852	0.691
1000.	1.000	1.000	0.999	0.998	0.992	0.972	0.947	0.918	0.889	0.750
2000.	1.000	1.000	1.000	0.999	0.998	0.992	0.983	0.972	0.960	0.889
3000.	1.000	1.000	1.000	1.000	0.999	0.996	0.992	0.986	0.980	0.937
4000.	1.000	1.000	1.000	1.000	0.999	0.998	0.995	0.992	0.988	0.961
5000.	1.000	1.000	1.000	1.000	1.000	0.998	0.997	0.994	0.992	0.972
6000.	1.000	1.000	1.000	1.000	1.000	0.999	0.998	0.996	0.994	0.979
7000.	1.000	1.000	1.000	1.000	1.000	0.999	0.998	0.997	0.996	0.984
8000.	1.000	1.000	1.000	1.000	1.000	0.999	0.999	0.998	0.996	0.988
9000.	1.000	1.000	1.000	1.000	1.000	1.000	0.999	0.998	0.997	0.990
10000.	1.000	1.000	1.000	1.000	1.000	1.000	0.999	0.999	0.997	0.991

TABLE XXXXIX (CONTINUED)

THEORETICAL EXACT DISTRIBUTION OF PROBABILITY OF SCATTER FACTOR FUNCTION FOR 2ND WEAKEST MEMBER OF FLEET

P(S)=NA*(NT*S/(NA+NT*S-1.))**NT-(NA-1.)*(NT*S/(NA+NT*S))**NT

NT=2.0 TEST RESULTS

SCATTER FACTOR FUNCTION (S)	NUMBER OF AIRCRAFT IN FLEET (NA)									
	5	10	25	50	100	200	300	400	500	1000
1.	0.229	0.081	0.016	0.004	0.001	0.000	0.000	0.000	0.000	0.000
5.	0.773	0.520	0.203	0.075	0.023	0.007	0.003	0.002	0.001	0.000
10.	0.912	0.756	0.425	0.201	0.075	0.023	0.011	0.007	0.004	0.001
20.	0.972	0.904	0.677	0.421	0.200	0.074	0.038	0.023	0.016	0.004
30.	0.986	0.949	0.797	0.572	0.318	0.136	0.074	0.047	0.032	0.009
40.	0.992	0.969	0.861	0.673	0.419	0.199	0.115	0.074	0.052	0.016
60.	0.996	0.985	0.924	0.794	0.570	0.317	0.199	0.135	0.098	0.032
80.	0.998	0.991	0.952	0.859	0.672	0.418	0.279	0.199	0.148	0.052
100.	0.999	0.994	0.967	0.898	0.742	0.501	0.353	0.260	0.199	0.074
150.	0.999	0.997	0.984	0.946	0.845	0.649	0.501	0.394	0.317	0.135
200.	1.000	0.998	0.990	0.966	0.897	0.741	0.607	0.501	0.417	0.198
300.	1.000	0.999	0.995	0.983	0.945	0.844	0.741	0.649	0.568	0.317
400.	1.000	1.000	0.997	0.990	0.966	0.897	0.818	0.741	0.670	0.417
600.	1.000	1.000	0.999	0.995	0.983	0.945	0.896	0.844	0.791	0.568
800.	1.000	1.000	0.999	0.997	0.990	0.966	0.933	0.896	0.857	0.670
1000.	1.000	1.000	1.000	0.998	0.993	0.977	0.954	0.926	0.896	0.736
2000.	1.000	1.000	1.000	1.000	0.998	0.993	0.984	0.978	0.965	0.894
3000.	1.000	1.000	1.000	1.000	1.000	0.997	0.990	0.991	0.982	0.948
4000.	1.000	1.000	1.000	1.000	0.999	0.998	0.997	0.996	0.994	0.971
5000.	1.000	1.000	1.000	1.000	1.000	0.999	0.999	0.998	0.990	0.978
6000.	1.000	1.000	1.000	1.000	0.999	1.000	1.000	0.994	0.992	0.982
7000.	1.000	1.000	1.000	1.000	0.999	1.002	0.998	0.997	0.996	0.978
8000.	1.000	1.000	1.000	1.001	1.000	0.999	1.003	0.998	0.998	0.994
9000.	1.000	1.000	1.000	1.000	0.999	0.999	0.998	1.004	0.997	0.979
10000.	1.000	1.000	1.000	1.000	0.999	1.001	0.998	0.996	[illegible]	1.004

TABLE XXXXIX (CONTINUED)

THEORETICAL EXACT DISTRIBUTION OF PROBABILITY OF SCATTER FACTOR FUNCTION FOR 2ND WEAKEST MEMBER OF FLEET

P(S)=NA*(NT*S/(NA +NT*S-1.))**NT-(NA-1.)*(NT*S/(NA+NT*S))**NT

NT =3.0 TEST RESULTS

SCATTER FACTOR FUNCTION (S)	NUMBER OF AIRCRAFT IN FLEET (NA)									
	5	10	25	50	100	200	300	400	500	1000
1.	0.183	0.046	0.005	0.001	0.000	0.000	0.000	0.000	0.000	0.000
5.	0.773	0.497	0.157	0.042	0.008	0.001	0.000	0.000	0.000	0.000
10.	0.916	0.755	0.392	0.154	0.041	0.008	0.003	0.001	0.001	0.000
20.	0.974	0.908	0.669	0.388	0.153	0.041	0.016	0.008	0.005	0.001
30.	0.987	0.952	0.797	0.554	0.276	0.092	0.041	0.021	0.013	0.002
40.	0.993	0.971	0.864	0.666	0.386	0.152	0.074	0.041	0.025	0.005
60.	0.997	0.986	0.927	0.794	0.552	0.275	0.152	0.092	0.060	0.013
80.	0.998	0.992	0.955	0.862	0.664	0.384	0.234	0.152	0.103	0.025
100.	0.999	0.995	0.969	0.901	0.740	0.476	0.313	0.214	0.152	0.041
150.	0.999	0.998	0.985	0.948	0.848	0.638	0.476	0.358	0.274	0.092
200.	1.000	0.999	0.991	0.968	0.900	0.739	0.594	0.476	0.384	0.152
300.	1.000	0.999	0.996	0.985	0.948	0.847	0.739	0.638	0.552	0.273
400.	1.000	1.000	0.997	0.991	0.968	0.901	0.819	0.739	0.661	0.385
600.	1.000	1.000	0.999	0.996	0.984	0.947	0.898	0.849	0.790	0.550
800.	1.000	1.000	0.999	0.998	0.992	0.969	0.937	0.899	0.861	0.663
1000.	1.000	1.000	1.000	0.998	0.993	0.977	0.954	0.930	0.899	0.737
2000.	1.000	1.000	1.000	0.999	1.000	0.992	0.986	0.980	0.967	0.899
3000.	1.000	1.000	1.000	1.000	1.000	0.999	0.994	0.990	0.980	0.941
4000.	1.000	1.000	1.000	1.000	0.999	0.998	0.997	0.995	0.993	0.966
5000.	1.000	1.000	1.000	1.000	1.000	0.999	0.999	0.997	0.996	0.988
6000.	1.000	1.000	1.000	1.000	1.000	1.000	0.995	0.999	0.998	0.979
7000.	1.000	1.000	1.000	1.000	0.999	1.002	0.998	0.997	0.996	0.989
8000.	1.000	1.000	1.000	1.001	1.000	0.999	0.999	0.998	0.997	0.993
9000.	1.000	1.000	1.000	1.000	1.000	0.999	0.998	0.998	0.997	0.993
10000.	1.000	1.000	1.000	1.000	0.999	1.001	0.997	0.996	0.995	1.003

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13. ABSTRACT

An analytical program to evaluate a probabilistic analysis approach to the prediction of aircraft structural fatigue endurance using data obtained from the C-130 Structural Integrity Program has been completed. This report is the final report of this program.

The proposed method is applied to three fatigue sensitive areas of the C-130 center wing using test results from C-130 B and E wing full scale fatigue tests. The results of this analysis are then correlated with service experience data from the Air Force's fleet of C-130 B and E transport aircraft. In addition, this data is also used to consider the applicability of the basic distributions and parameters selected for the proposed method.

The first and second phases of the program involve the preparation of this data and the correlation of the results of the analysis with the data used as a single population. The third and fourth phases of the program involve the selection of four C-130 service usage groups, the adjustment of the fatigue test results to the usage group loads and the correlations of the results of each analysis with the data from each usage group. The fifth phase involves a review of the results of the correlations made in this study.

This study indicates that eigher the log-normal or Weibull distributions with the proposed shape parameters fit C-130 in-service crack initiation as well as present knowledge could predict. Predictions made with the proposed method are significantly more conservative than their normal reliability values would indicate.

(Continued)

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
a. Fatigue-Life Variability						
b. Aircraft Structural Fatigue Performance						
c. Reliability Analysis						
d. Statistical Analysis						
e. Order Statistics						
f. Estimation Theory						
g. Scatter Factor						
h. Safe Life						

Security Classification

13. Abstract (cont'd)

It is recommended that a modification of the present method be considered which uses crack occurrence results from the fleet along with the fatigue test results for estimating the fatigue endurance.